PROCEEDINGS OF
RESOURCE ROADS WORKSHOPS
WHITEHORSE AND YELLOWKNIFE
MARCH 16-20, 1981

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INTRODUCTION

Workshops were held in Whitehorse on March 16, 17, 1981 and in Yellowknife on March 19, 20 in order to obtain perspectives on key northern resource road environmental issues and on the strategies which are needed to resolve those issues. This report contains a full account and a summary of the 13 papers presented and discussed at the workshops.

Such gatherings are needed primarily because environmental impact assessment is such a new field. Most of the really good information on the subject is unpublished and unsynthesized and periodic gatherings are needed to pin-point the key issues, encourage the synthesis of project-specific information into a broader, more generic point-of-view and promote the exchange of information amongst those active in the field. The resource roads workshops also resulted in a number of policy and environmental design suggestions which hopefully will provide a partial basis for government-industry action.

The workshops were organized by EPS offices in Vancouver, Edmonton, Whitehorse and Ottawa and by Hardy Associates, Edmonton. The chairman was Carl Surrendi, Hardy Associates.

ACKNOWLEDGEMENTS

The organization and running of the workshops and the subsequent editing of the Summary Report involved the following people:

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WHITEHORSE WORKSHOP

RECOMMENDATIONS AND SUMMARY

RECOMMENDATIONS OF WORKSHOP PARTICIPANTS

It is recommended that:

1. The role of the Land Use Advisory Committee (LUAC) should be formalized. At present it is simply a gathering together of people at the request of the DINA Engineer. It has no authority i.e. there is nothing in the regulations that requires the establishment of such a committee. Nor does its' advice have to be taken. The chairman of the LUAC should be responsible for the coordination and integration of information and activities of resource managers, road planners, and the public. The public should be made aware of the existence and location of this service to them.

2. The LUAC should meet to develop specific criteria for the sorting of Land Use permit applications. The purpose of the criteria would be to direct permit applications to either DINA Land Use Staff or the LUAC. Environmental screening guidelines specific to Yukon roads should be produced by the Northern Environmental Protection Branch, DINA in conjunction with the appropriate Regions, other Government Departments and resource agencies.

3. Environmental requirements for roads should apply to roads on claims and leases under the Yukon/NWT mineral legislation.

4. Important environmental issues should be identified early in the environmental assessment process.

5. If the environmental effects of proposed road projects are unknown or significant, sufficient time should be allowed for the completion and review of an Initial Environmental Evaluation or, if necessary, an Environmental Impact Statement.

6. Detailed guidelines for initial environmental evaluations (I.E.E's) should include a flow chart denoting the exact procedure that a proponent must follow to meet the I.E.E. requirements and a detailed set of I.E.E. guidelines for roads in the Yukon.

7. Part of the impact assessment process should include an examination of route alternatives from an environmental as well as an economic and engineering viewpoint. While it is recognized that social impacts are important, they are beyond the terms of reference of this workshop.

8. Alternative transportation modes should also be considered and the "no-go" option should be one of the alternatives.

9. After considering alternatives and, where a road is perceived to be required, the planning of the road for initial access to an area should include the needs of other non-renewable and renewable resource users. Road planning must be considered in the context of regional transportation and land use planning and resource management plans and programs.

10. A time limit of 42 days should be allocated for the environmental screening of road projects.

11. Increased access places additional requirements on staff and manpower of fish and wildlife agencies. Efforts should therefore be made to supplement resources and manpower to ensure that these agencies can handle the increase in demands upon their services.

SUMMARY OF PAPERS AND DISCUSSIONS

a) Items concerned with construction and design technique:

- Erosion problems are the major environmental concern encountered by DIAND's Land Use Section in the Yukon. Control methods include terracing, placement of brush, debris, trees or mulch, soil scarfication, use of trenches to control subsurface ground water flow, use of ditch blocks, interrupter off-shoot ditches, cross ditches and revegetation. Route selection is also an important factor in controlling erosion problems.

- Problems regarding the correct installation of culverts for fish passage have improved substantially. The principle improvement has been an increased tendency to install inverts below the original streambed, maintain the original stream slope and stabilize inlets and outlets.

- The negative aspects of a right-of-way is that it eventually grows back and has to be cleared regularly. The Shakwak project adopted a cleared right-of-way of 7-9 metres and varied the clearing width in consultation with a DPW landscape architect. Areas of scenic beauty were also identified and pull-offs were provided.

- Borrow pits on the Shakwak project were screened from the highway and when closed, slopes were graded to 2 to 1. Top soil was returned to these slopes in sufficient thickness to be of practical use.

- On the Shakwak project all clearing was done by hand at stream crossings where bank erosion and stream siltation might cause environmental problems. Grubbing was not performed in such areas. Culverts were sunk below the bottom to duplicate the natural stream bed. Rocks were also placed in the streams in some instances to provide eddies and slow moving currents to assist fish passage.

- Active solutions to culvert icing problems such as electric cables and steaming are costly and so on the Shakwak Project a passive solution was tried. It involved a main culvert to pass summer water and two underdrains to pass water beneath the ice cover. The underdrains connect rock lined catch pools at the upstream and downstream ends of the crossing. The design has worked effectively for two years.

- Reconstruction camps for the Shakwak Project were established at existing road maintainence camps and pump stations.
- DPW (Yukon) is seeding erosion-prone slopes on the Shakwak project to retard the return of spruce, willow and poplar to the right-of-way. This will also prevent continued disturbance of the road by YTG maintenance crews using road graders.
- It is not costly to install culverts on the stream gradient and culvert inverts below the stream bottom to ensure fish passage. On the other hand it is costly, by a factor of 2-4 times, to ensure fish passage by increasing culvert diameter. Nevertheless, it can be argued that this increased cost ought to be absorbed, particularly if fish habitat is scarce in the area eg. 2-3 streams/100 miles and if this cost is small relative to the over-all cost of the project. In addition, the cost of increasing culvert size can result in reduced maintenance costs.
- Brush can be used to control erosion and also provide wildlife habitat. In the Yukon, all brush is removed on major and secondary roads. It is not burned on sections which are unlikely to be seen by the public.
- The northern road location engineer generally begins to look for a route for a road using aerial photographs and 1:250,000 topographic maps. He has to know which soils are best eg. the fine grained soils adjacent to the Mackenzie River have a high ice content and make a poor embankment material but soils a little distance away from the river are much better for road construction.
- An uncontrolled mosiac of aerial photographs is laid out and by this stage the route is narrowed down to a band several kilometers wide. Some of the other information which is used to select the route are maps showing wildlife habitat, migration routes, waterfowl nesting areas, etc. Forest cover maps are also used, when available, to give clues regarding the type of soil and topography.

  After the location engineer has sketched out his route on the mosaic, selected potential areas for borrow material and noted potential problem areas he flies the route. By this time the route is fairly well defined, although alternative routes may be indicated in certain places.
- The most serious problem with northern road location and construction is the shortage of gravel and good material for the embankment.

b) Items concerned with Assessment Procedure:

- Environmental impacts ought to be addressed at the planning stage of northern roads projects, not left until construction begins or until after the roads have been completed. Alternatives which can limit environmental impacts can be considered at that time, including the alternative of not proceeding with the project at all. The analysis of alternatives should also consider more than just economic costs and benefits. Wilderness preservation and native life style maintenance also need to be taken into account.
- Roads should not be held sacrosanct in the Yukon. There are other ways of developing areas and the no-go option should always be considered eg. by determining the feasibility of other modes of transport.
- Being able to develop a single corridor to serve multiple resource uses in an area means that we must have more resource information (renewable and non renewable) than is currently available. Ordinarily, if that information is lacking the road is routed in the most direct way possible to known resource locations.
- Erosion control at or near stream crossings is an important area of concern throughout the year, not just during spring run-off when streams often carry a high sediment load anyway. The problem becomes especially critical when important fish spawning and rearing areas are located in the vicinity of the crossing.
- Improved access to areas for hunting and fishing can create management problems for fish and wildlife agencies. Further efforts are needed to coordinate their ability to manage the improved access and the activities of resource road developers.
- Fisheries studies at stream crossings are generally a one shot effort over a short period of time and may not provide conclusive evidence on the presence or absence of fish. It is probably safer to assume fish are present and design for it.
- Winter access roads to mining properties are regarded as minor operations, yet they often define the routes taken by subsequent all weather roads. Their importance, in terms of defining the nature and scope of subsequent resource road development needs to be recognized in the assessment process.
- There is not enough information to prepare sensitive area maps for large areas of northern Saskatchewan to identify environmentally acceptable routes for new roads.

Ordinarily, a few broad corridors leading from a starting point to a destination are identified by the proponent. These take into account the many terrain restrictions which exist in this part of the province. An environmentally acceptable route is then selected within 2-5 kilometers of the line(s) chosen by the proponent.

c) **Items concerned with Policy and Planning:**

- The permit system does not have control over roads cut on leases and claims.
- Northern roads planning ought to involve public participation and include the funding of native and environmental groups.
- The planning for specific resource road projects should be integrated into an ongoing land use planning process.
- Existing environmental impact assessment and resource road planning processes are defective in that there is no effective linkage between the assessment and planning processes to ensure that maximum benefit is gained by planners from the impact assessment information collected.
- Once you build a road into an area you open up the resources for future development. A large unplanned network of roads may result unless a more anticipatory approach is taken by Government. One approach which has worked elsewhere is for government to identify areas or corridors where permit applications will be accepted. Detailed environmental studies are not involved at this stage.
- Experience with the Liard and Mackenzie Highways and resource roads in general suggests that environmental design improves dramatically if concerns are identified and taken into account during project design. It spells the difference between achieving high standards of environmental design and applying band-aids to open wounds.
- A full time environmental coordinator is needed for large projects such as the Shakwak Project to coordinate the mass of environmental work and to over-see monitoring activities. He is also needed to develop site-specific guidelines for use by the resident engineer at the conceptual design stage, design stage, contract preparation stage and contract administration stage. The need for a full time coordinator is somewhat lessened at the contract administration stages and in the case of the Shakwak project he is only required on a part-time basis.

- Invariably, when a road is built animals are attracted to it. The greater the area of disturbance eg. exceptionally wide cleared rights-of-way, the greater the attraction. Although wildlife habitat improvement may be counted a benefit there are two important costs:
  (i) over-hunting due to improved access,
  (ii) big game collisions (if you run into a horse, cow or moose in the Yukon the driver is at fault).

  These benefits and costs need to be addressed at the early-on planning stages of resource roads projects. The real managers of wildlife habitat and hence of wildlife in the North have been road and pipeline builders. More needs to be done to ensure that this "management" is effective.

- The lack of a comprehensive land use policy means that other legitimate land uses such as trapping, outfitting, recreation and fishing are considered to be inferior to that of the mining industry. A comprehensive policy ought to include environmental standards for road construction, environmental siting criteria and a requirement to do terrain analysis prior to the issuing of permits (including wildlife, habitat, vegetation and soil). Winter roads and tote roads should be included in the policy statement. The tote road assistance program (or Northern Exploration Facilities Program) should be repealed or incorporated into a more comprehensive subsidy program which includes trappers and outfitters who may wish to put in an access road or horse trail.

- No mechanism exists to deal with roads when they are abandoned - should they stay open or closed and under what conditions?

- The review period (10 days) for land use permit applications is far too short. More time is needed for review by other land users in the area, interest groups and the public in general.

- One of the greatest difficulties encountered by road construction agencies when implementing an environmental assessment process is the lead time requirement. In Saskatchewan, the time needed to do the assessments was not built into the road delivery program at first, and as a result environmental assessment was percieved as an extraneous activity imposed on traditional design and construction functions. With the exception of time delays, design and construction plans were only minimally changed. Now 4 weeks to two years are allowed for assessments from the day an application is received. An engineering environmental coordinator position was created and incorporated into the design and planning functions of the Department to coordinate the environmental activities associated with northern Saskatchewan road projects. Steps were also taken to seek out environmental and land use issues in proposed development areas by hiring, on a contract basis, liaison persons to supply the Department's information to the communities and vice-versa. These people identify the location of renewable and non-renewable resource users and assess the impact of the road project on them. By doing this, problems can be identified and dealt with fairly readily during the formal public review period.

- The Saskatchewan Department of Environment has drafted road construction guidelines which should reduce the need for a lot of environmental impact statements. Projects would be approved via the screening process, subject to agreement with the guidelines.

YELLOWKNIFE WORKSHOP

SUMMARY

SUMMARY OF PAPERS AND DISCUSSION

a) Items concerned with construction and design technique

- Minor stream crossings sustain enormous impacts in both Territories yet they are important in maintaining wetland habitat, for flood control and in some instances may flow into fisheries streams. Much of the impacts are the result of Territorial government maintenance activities. On the Howards Pass Access road it has been suggested that culverts at minor stream crossings be removed because of washout problems. Fords should be used instead.

- Culverts should be on the natural stream gradient, aligned with the stream channel and inverts should be below the stream bottom.

- Temporary erosion control plans are needed to deal with erosion problems when construction is underway. A permanent erosion control plan should also be required of proponents. It would indicate how erosion will be controlled once the road has been completed.

- Brush barriers are effective in controlling erosion and should be given serious consideration in areas where rip-rap is scarce. The primary consideration in making this decision should be environmental protection not aesthetics (the brush can be removed once a vegetative mat has been established).

- Foreslopes are usually constructed too steeply in the Yukon - a 30 degree slope (or less) with rip-rap should be utilized when silty sandy material is involved.

- Ideally, a minimum environmental disturbance policy should be adhered to at all stream and river crossings yet in many cases the amount of disturbance in these areas is actually greater than in other sections of road. Leaving an undisturbed buffer of vegetation along stream banks can help enormously in areas which do not have to be cleared immediately. On the Shakwak Project they hand cleared vegetation at many stream crossings.

- More attention should be given to the Bailey Bridge when deciding amongst alternative stream crossing structures. They cause virtually no environmental disturbance and are used routinely in northern Saskatchewan where traffic volumes are surely no greater than they are in the Territories. DIAND commissioned a report by Damas and Smith which provides a means for looking at the environmental as well as the economic costs and benefits of Bailey Bridges and other types of crossing structures.

- Funding is an issue that has to be addressed when deciding how much erosion control will be undertaken at stream and river crossings. Many of the erosion control techniques used in express ways in Southern Canada, for example, would likely be too expensive to be applied in the north.

- The lack of pre-planning at stream crossings is a major issue. A temporary erosion control plan should be required of proponents to indicate what will be done to control erosion at all stream and river crossings during construction. For example, a smaller right-of-way could be utilized at crossings, undisturbed vegetated buffers could be left in certain streambank areas, vegetation at crossings could be winter cleared so as not to disturb the soil until absolutely necessary. There is really no lack of such information. Proponents can use it to define effective and economical erosion and sediment control measures which can be used in conjunction with construction activities.

- Engineers design million dollar bridges on large scale northern roads. Wooden bridges represent a more environmentally and socially appropriate technology for the Canadian north. They can be used for temporary crossings in the early stages of road construction, can be constructed by Hire North, are simple in design, can be installed by a crane operator and a team of laborers from the local population (who can later be trained as crane operators and pile drivers and eventually take over the whole operation), native timber resources can be used, stream beds and stream banks are left undamaged thus protecting fish resources from erosion and siltation effects, time is made available for further hydrological studies if the timber bridges are installed on a temporary basis (on the Liard Highway the problems with the lack of hydrological data could have been resolved if temporary wooden bridges had been used, then time would have been available to develop good crossing designs based on long-term hydrological data), costs are low relative to those required for concrete and steel structures, northern cold acts to preserve wooden bridges for a long time (on the Canol Road some are still standing after 35 years), costs of highway design and construction can be phased over time if wooden bridges are used first and later replaced by expensive concrete or steel structures.

- Wooden bridges are used routinely in British Columbia, Quebec and New Brunswick. It would be useful to approach the highway Departments in these provinces for information and then begin installing wooden bridges in the north on a trial basis. The trials would be used to establish the viability of this technology in terms of capital and maintenance costs.
- Wooden bridges should not be treated since the chemicals used are toxic to fish.
- A disadvantage of wooden bridges is that they are more difficult to inspect and maintain than a culvert. Another is that they don't last as long as steel or concrete structures in the north, although they do last a long time. Finally, culverts are relatively inexpensive and easily installed.
- Subsurface water flows through sand overlain by a relatively impermeable glacial till can cause difficulties in highway construction and impacts on fish resources. In Saskatchewan in the Lac La Ronge area this type of terrain has been crossed by numerous roads and highways. They interrupt sub-surface drainage, cause impoundments, drown forests and delay water flow into walleye spawning streams during the critical spring period. Culverts are not effective in transmitting this sub-surface flow. Additional problems are caused by raised culverts, sedimentation at culvert inlets and excess water velocities in fish streams. These problems can only be addressed by conducting thorough investigations of drainage hydrology, by pre-planning the environmental aspects of highway construction and by providing drainage in the road bed in terrain susceptible to this problem. What is also needed are innovative engineering designs for roads which would allow the sub-surface drainage to flow under the road unimpeded. The problem of interrupted drainage is not unique to Saskatchewan; it occurs in the Territories too.
- It is possible to maintain surface drainage when crossing minor streams by using rip-rap for the sub-grade and building the road on top of that. The same principle might also work if applied to sub-surface drainage in critical areas i.e. replace the impermeable layer beneath the road bed with a permeable material which will not compress and cut off sub-surface flow.
- Culverts can have a major impact on the fish resources of a watershed by restricting, delaying or preventing their upstream migrations. The most important migration is the spawning run although fish also migrate to seek food, overwintering

areas or favorable habitat. Considerations in designing culverts for fish passage include: (a) placing culvert inverts below stream bed elevation; (b) avoiding concentrated water drops at the inlet and outlet; (c) reducing the culvert length to the minimum possible; (d) scheduling construction activities so they do not interfere with spawning migrations or egg incubation periods and avoiding deleterious effects on fish habitat; (e) minimizing hydraulic losses and the possibility of debris or ice jam blockages; (f) protecting against erosion; (g) investigating the possibility of selecting an economic bridge for the site.

Designing a plain culvert with a mean water velocity of one meter/second is not practically or economically feasible in most cases. Even the largest walleye, the best performer of the species investigated to date could not advance very far against such a velocity. Design solutions include: (i) installing tailwater controls 5 to 7 pipe diameters from the outlet, (ii) back flooding by constructing a notched weir downstream from the culvert outlet, installing baffles or blocks inside culverts to provide resting zones for fish, (iii) simulating stream conditions inside culverts by installing inverts below the stream bottom and filling to stream grade using a notched layer of non-uniformly laid rip-rap as the top layer.

Structures that retain natural stream properties at the crossing such as wooden bridges and open arch culverts should be investigated; they may provide a more economical alternative to culverts, particularly where large cross-sectional areas are needed to maintain acceptable water velocities.

- Culverts have been rip-rapped on the Liard Highway to simulate the natural stream environment. A maintenance program will be needed because ice may take out some of the rip-rap. Another potential problem is that in the early spring the rip-rap in the culverts may be still embedded in ice and hence would not be effective in reducing culvert velocities for spring spawners.

- Revegetation in silty soils is poor in ditches on the Liard and Mackenzie Highways. Ditch blocks which are now used are generally ineffective. Design solutions include sandbags (expensive and tried on the Mackenzie Highway in some areas), place ditch blocks deeper into the soil, use more ditch blocks and space them more closely together, use brush by itself or in combination with rip-rap, in areas where only small rip-rap is available (as on the Liard Highway) use gabions (the technique is expensive but costs can be reduced by buying the wire and making them oneself).

- Erosion and sedimentation problems at stream crossings can be reduced in silty soils by:

  (i) requiring that the removal of borrow material on the right-of-way be prohibited in the vicinity of streams (this guideline is used in Saskatchewan),

  (ii) narrow the approach to stream crossings during the summer and leave the land clearing around the stream until winter. In the spring, vegetation will grow back because the topsoil hasn't been disturbed. The vegetation acts as a buffer around the streams and protects them until it's time to begin construction at the crossings.

- Approximately ninety percent of the culverts on the Howards Pass Access Road wash out each year. The problem appears to be icing and possible underdesigning. The problem could be solved by using fords rather than culverts on all streams not containing fish. A guideline for determining the presence or absence of fish in streams in this area is: if the stream has a gradient of more than 10 percent it probably does not contain fish; if the gradient is less than 10 percent then fish may be present and fish passage culverts need to be used.

- Care will have to be taken when creating habitat to ensure that big game-vehicle problems are not created.

- Maintenance staff should not use road graders in the vicinity of stream and river crossings. Such areas should be clearly marked to assist the equipment operator. When maintenance clearing is required, it should be done by hand or by mower. The buffer zone size can be varied as in Saskatchewan according to the size and importance of the stream or else a standard limit for maintenance clearing could be adopted eg. 100 meters.

- Shoreline vegetation removal should not take place at river and stream crossings prior to culvert installation. Narrower rights-of-way should be used in the approaches to river and stream crossings and vegetation should be cleared during the winter prior to the installation of the crossing structures.

- Specific sites should be designated for waste fill and should be well removed from rivers and streams.
- Heavy equipment should be kept clear of shoreline areas on either side of crossing structures except when and where they are absolutely required. Sections of shoreline which are not to be disturbed should be clearly marked to assist heavy equipment operators. An environmental briefing program should also be developed for heavy equipment operators.

b) Items concerned with Assessment Procedure

- In most cases there is no need to assess the environmental impact of proposed northern resource roads because the kinds of impacts which can be expected are known. What is needed is proper environmental design, thorough inspection during construction and more intensified management of the resources to which access is being provided.
- There are only two environmental impacts of any consequence that cannot be mitigated: (i) it is still not known whether roads can be compatible with migratory caribou and (ii) it is known that roads are never compatible with wilderness. For the rest, all that is needed is adequate site-specific environmental information to reveal problems and adequate environmental design to solve them.

Unfortunately, knowing how to solve environmental problems and being able to do so are two different things. To ensure that these problems are solved it is recommended that: (i) Since every new road means more work for environmental management agencies it is essential that appropriate staff and budget allocations be made. (ii) We should identify areas of importance to migratory caribou and areas of national or regional significance for wilderness values. The best agencies to undertake this task are the two Territorial Game Branches and Parks Canada using mechanisms already developed and following initiatives already taken. (iii) For other areas, approval in principle should be automatic. Final approval should be withheld until the appropriate environmental management and protection agencies are satisfied that sufficient environmental data has been obtained and that environmental design is adequate.

- The environmental damage done on the Howards Pass Access Road will heal over time although it will take a few years. The real problem is access to an important wilderness area. This problem and the increased pressure on fish and wildlife resources which is associated with it are not addressed in the environmental approvals process.
- Avoidance of critical wildlife areas should be one of the first rules of northern road corridor identification. Avoidance of such areas as wintering ranges, rutting and concentration areas and caribou calving and post-calving grounds is the best solution to minimizing impacts. Avoidance measures can also be applied during right-of-way selection to minimize local impacts. Temporal measures can be used to schedule construction operations so as to avoid critical periods in the life cycles of wildlife populations. Operational measures eg. environmental codes of good practice can be used to control construction activities.
- Road development programs must include environmental information from its initiation. A lead time of 2-3 years may be necessary to complete wildlife inventory programs. The design process must be geared to incorporate environmental information during all stages of development, from concept to final design. A coordinated interdisciplinary approach is required to identify information gaps, establish research priorities and ensure communication amongst the various project specialists.
- Environmental assessment as a one-shot, front-end component of road development programs should be replaced with a more comprehensive, integrated approach; one which involves environmental management, links with road planners, designers and engineers and which continues through to post-construction monitoring.
- There is a need for selective wildlife studies to accompany road development from concept through to operation and abandonment. What we need to learn are the long-term effects of roads on wildlife. Unfortunately, techniques to study wildlife reactions to linear disturbances are lacking. Steps to develop these techniques have been taken by the NWT Wildlife Service in cooperation with the Canadian Wildlife Service and Alaskan biologists. This should lead to the collection of quantitative evidence on the ways in which roads affect wildlife movements, population size and

structure, etc. Studies are also hampered by a lack of pre-development information on wildlife population distribution and abundance.

- It takes 2-3 years to collect the necessary information on wildlife distribution and abundance in order to identify specific problems. Ordinarily, the information that is available is regional in nature and cannot be used at the detailed level to identify problems in a specific corridor eg. no formal studies have been conducted to map out the winter areas for sheep in the Nahanni range in areas crossed by the Cadillac Winter road. All that can be said with the information available on sheep is that there could be major problems.

- A lot of the money that is allocated to the impact assessment process goes into the inventory phase and may not, by itself, be useful in making decisions regarding northern road projects. We should use existing information as much as possible and be very selective in the studies that are conducted to ensure that they improve our ability to make decisions.

- One of the problems with environmental assessments is that no one seems to understand or be in agreement regarding the level of detail and amount of field work that is required. There is a big difference between a helicopter over-flight of an area and a review of available literature at the broad regional level on the one hand and on the other, field investigations to determine sheep distribution and abundance in areas to be crossed by a proposed access road. The consultant has an opinion on the matter, the company probably has another view and government agencies have their preferences. There should be some standardization or agreement at the start of assessment studies regarding the kind of detail that is needed to ensure that the environment is protected. Having said that, it should be made clear that as a first priority wildlife agencies have to come to grips with the problem of general hunting licences where people can shoot as many caribou as they want. They must deal with the simple fact that people are getting access to new wilderness areas and can shoot too many animals. No other issue is as important as this one.

- In Saskatchewan the terms of reference for environmental assessments are developed in a collaborative manner between the proponent and government agencies. Proposed studies are reviewed by Government and Government itself may suggest that particular studies be conducted. The view is taken that if a company wants to extract billions of dollars worth of uranium from an area then it should be prepared to spend sufficient time and money to assure the Government and the people that the environment will be protected.

- Much of the environmental disturbance caused by resource road construction is beneficial to wildlife. But this benefit is not optimized because habitat managers within wildlife agencies do not usually collaborate with mining companies etc. to take advantage of the opportunities provided - to create waterfowl habitat at an abandoned borrow pit, to increase moose browse production by pattern cutting 2-3 acre patches near a moose wintering area etc. The cumulative effect of many such small initiatives would be significant. Small scale habitat manipulation would have a negligible effect on caribou habitat (climax forest).
- Although planned rather than accidental wildlife habitat manipulation is advocated along resource roads and in association with mining projects there will always be certain wilderness areas where disturbance of any kind should be prevented. There will also be areas where wildlife production is already high and where additional habitat manipulation may not be necessary.
- The opportunities available for fisheries habitat enhancement along resource roads should be explored, as for wildlife.
- The environmental monitoring of existing linear facilities can be a useful tool for planning. Such information will help answer a lot of questions regarding the environmental impacts of roads and pipelines and hence will reduce the need for large scale environmental assessments. It is therefore recommended that the Beak Linear Facilities Study, initiated by EPS, Western and Northern Region several years ago, be completed.

c) **Items concerned with Policy and Planning**

- Improved coordination of Federal environmental monitoring activities is required. DPW, for example, believes it is doing a good job in building roads and if people have environmental concerns they should coordinate their monitoring efforts and let the proponent Department know the results. Similarly, the Chief Engineer for the Liard Highway Project should be advised of environmental problems in a coordinated way by all those agencies monitoring the project - DFO, DOE, DIAND and GNWT. A single voice is needed to communicate these concerns and to indicate what should be done about them. A precedent exists - a coordinating position was established in Yellowknife to coordinate inspection activity for Mackenzie Highway construction. That position has, of course, been done away with.

- A coordinating agency (Environmental Control Board) is needed to deal with environmental protection matters; one which draws together all agencies with an environmental protection mandate and ensures that wildlife and fisheries interests and the public are represented. Such a coordinating body is used in Northern Saskatchewan and is found to be effective from the proponents' point-of-view. He can't deal effectively with all the water rights, Boards, Fisheries interests, federal government regulations etc. The single window is also found to be effective from the point-of-view of fish and wildlife agencies and others.

- Part of the problem with resource roads is not so much the fact that we lack in recommendations and good environmental design practices. It's the implementation mechanism that leaves a lot to be desired. It is therefore recommended that as an initial step, all the Boards, Committees and other government decision-making entities which are relevant to northern resource roads be listed. An effort should then be made to note how they interract and give serious consideration to consolidating all decision-making entities by, for example, creating an Environmental Control Board.

- The major concern of northern roads is whether additional wilderness needs to be opened up. The Cullaton Lake property is being developed without a road - everything is flown in. Cadillac Development uses only a winter road to develop their property. If this approach were taken for the Howards Pass Access Road it probably would not have been built. Now we have to suffer the environmental and other impacts associated with opening up an important wilderness area.

  In order to make a decision on this issue we need information so that advance planning can be done eg. the reason given for the Howards Pass Access Road is that they wanted to get 1500 - 2000 tons of storage in for underground exploration, but they had an airstrip on their property and probably could have had their supplies flown in.

- Environmental agencies have gotten bogged down in arguments which perhaps can only be resolved by widening the forum to include the construction worker, the design engineer and environmentalists. This is the best and perhaps the only way to achieve proper environmental design. Coupled with this you need thorough inspections and the staff to alert contractors to environmental problems.

- The environmental and social costs of resource roads, both short term and long term, are borne by northern residents even though the economic benefits accrue to all Canadians. In the case of large scale roads, all key decisions are made in Ottawa. In the case of small-scale roads over which the GNWT has control, the public has no access to the decision-making process.
- The Environmental Review Committee met in the spring of 1980 with Cadillac Mines representatives, indicated that there was little available environmental information for the area and hoped that the necessary field work could be done as part of an IEE. Unfortunately, the company wanted to begin construction of their access road in the summer and so their consultants only spent 3-4 days looking at the area by helicopter. Consequently, a number of government departments weren't too happy with the results. Nevertheless, DIAND approved the project.
- The Cadillac ore body, the Izok Lake property, Salmita, Cullaton Lake and Contwoyto Lake have been known for a number of years. Yet Government does little environmental work in these areas until the eleventh hour, when a company wants to develop its property. Departments should be doing something ahead of time, not always reacting after the fact.
- You can never get a mining company to tell you ahead of time what they want to do. But once they've decided to develop a property they want their approvals yesterday. It's an area where government has to keep track of what's happening and has to allocate resources so that resource development projects are dealt with over the long term.
- Wildlife and fisheries extension specialists could work with northern resource developers in the same way they now work with private land-owners in southern Canada in order to improve wildlife habitat. Another potential client will be northern natives, once they get their land claims settled. Many practical research questions will be asked by these people about very practical problems and the wildlife and fisheries specialists will have to be ready.

- Highway maintenance practices at stream and river crossings should compliment any environmental protection efforts made during construction operations. A road maintenance manual should be prepared to ensure that this happens.
- The problem with some resource roads is that they only satisfy the needs of a single user. The needs of hunters and those who would like access to a wilderness area eg. Nahanni Park all need to be taken into consideration in road planning.
- The only thing about Cadillac Road that DOE was upset about was the fact that one section was permanently built prior to the issuance of final approval for the mine.
- The Department of Indian Affairs and Northern Development doesn't do land use planning in the NWT. They're waiting for land claims to be settled first and this reality needs to be taken into account by anyone advocating a planned approach to resource road development in the North. That is not to say that a lot of background work is not being done.
- This workshop should not develop guidelines. Perhaps what we should be doing is locating guidelines, putting them together and getting them to the appropriate people. At that point the problem becomes one of improving the administrative machinery to ensure that the guidelines are implemented. For example, the permitting process needs to be streamlined and Government has to stop reacting to projects in a piece-meal incremental fashion. Projects have to be dealt with in an integrated way well in advance of receipt of the first permit application.
- Permitting agencies have to come up with better definitions of what constitutes mineral exploration and what constitutes development.
- The short time frame allowed for review of permit applications has to be addressed.
- A basic operation principle in the north is that, except under extraordinary circumstances, whoever has a mining property or an oil well etc. will be allowed to build a road to obtain access. Approval in principle for these roads should be automatic with emphasis placed on proper environmental design. The no-go option would only apply in pre-designated areas of high national or regional importance. This requires comprehensive land use planning at a regional level. Detailed sensitive area mapping would only take place at the local level as part of environmental planning for a specific project.

- A lot of the locations for fairly large mineral deposits in the north are already known. The same is true for some regionally and nationally significant environmental areas so it should be possible to begin planning at the broad regional level right now. Evidently DINA is doing this now in Ottawa. A precedent exists for this type of work on Viscount Melville Island. EMR identified prospective drilling areas prior to issuing leases on the island and asked DOE to identify those areas which were or might be environmentally sensitive. Leases were then issued for all other areas.
- Since information on fisheries, wildlife, parks, forests and important mineral areas are known at the regional level it is recommended that a draft regional road transportation plan be prepared jointly by DINA, DOE, DFO and GNWT. The plan can be updated as new information is collected at the regional level. Evidently the Roads and Airstrips Division, DINA is doing this work now.

WHITEHORSE WORKSHOP

MARCH 16, 17, 1981

THE DEMPSTER HIGHWAY - A CASE STUDY OF GOVERNMENT DECISION-MAKING AND PLANNING FOR NORTHERN ROADS WITH SOME RECOMMENDATIONS

by

W.M. McLeod

My involvement in highway development was thru CARC. I was asked to do a study of the decision making and planning that was involved in the building of the Dempster Highway. The study has been published.

It's useful to look at the Dempster Highway since it provides an example of how the government has treated and regulated northern roads since the 50's. The highway was started as part of the "Roads to Resources" program which was begun in 1958 by the Conservative government. There were prospects for oil and gas in the Eagle Plain area and the road was to provide access to that area. Ultimately the road was to extend to the Mackenzie delta. 72 miles were built by 1961 but by then the Eagle Plains oil and gas prospects were no longer promising. There was a long pause until approximately 1968 when the Prudoe Bay field was discovered. At that time oil and gas prospects in the Mackenzie delta and the north slope made it seem profitable to continue building the highway.

Until the early 1970's no environmental impact studies were conducted in the north. A commitment to do these studies has slowly evolved thru the years. I think it is safe to say that the government regulates impacts as best it can. The trouble of course is that it's a lot harder to do something about environmental impact after you've built something eg. the Dempster Highway. I think this is the fundamental point about road development in the North; the impact has to be regulated at the planning stage, before construction begins. You have to consider the alternatives open to you which can really limit the impact of a development. In the case of the Dempster Highway, consideration could have included given to not opening the road. Hypothetical alternatives might have included expanding barging systems and improving air transport in the Mackenzie delta. After completing my study, Trimac and Quadra consultants prepared an economic cost/benefit analysis of winter operation of the road and their conclusions, which only considered operating costs during winter, was that winter operation was not profitable. That calculation did not take into account capital costs or impacts on caribou. So, with available economic data it is clear that the highway cannot justify itself on an economic basis. Therefore my first proposition is this: environmental impact assessment should begin with an examination of all alternatives including the alternative of not building the road and utilizing other forms of transportation. The analysis should also consider more than just the economic use for which the road was originally designed for. In the case of the Dempster highway it was the Eagle Plain oil and gas field benefits and later the development of Mackenzie Delta oil and gas which determined where and when the highway would be built. Land uses which compete with oil and gas development etc. should also have been considered. In particular, the use of the area for wilderness or maintenance of native lifestyle. There was never a time in the history of the Dempster highway when the idea of not building the highway was seriously considered. There was never a time when the use of alternative transportation systems was seriously debated. There was very little consideration of alternative land uses, although now highways are regulated with a view to not adversely affecting native lifestyles.

Another point I'd like to make is that the consideration of northern roads ought to involve public participation, including the funding of native and environmental groups. There were no effective hearings on the Dempster highway; There were two task forces that visited the north briefly in 1965, 1967, 1975. No visits were made to native communities; Background material was not provided in advance to special interest groups or to the public generally. Such materials would have enabled them to see what the government had in mind and would have contributed to the planning process by stimulating reactions to the government proposals. At a later hearing I understand that material was distributed at the meetings.

Government studies were suppressed in the development of the Dempster Highway eg. the Shultz International Consultants Overview Study. It was prepared in 1972 and not released to the Berger hearings until 1975, 1976 except, I believe, to selected individuals.

The highway was not integrated into an ongoing land use planning process. It's important and I think obvious that highway planning is merely a part of land use planning. Land use planning has to provide the overview in which highway planning takes place.

The construction of the highway was not based on adequate field data with regard to environmental issues. The material which has been generated by the pipeline studies has largely filled in a number of knowledge gaps. However, there are still unanswered questions regarding caribou behaviour in the vicinity of highways.

In conclusion, I attribute a lot of the problems with the Dempster Highway to what I facetiously call the CPR complex i.e. the notion that you can build a road or a highway or a railway almost anywhere and it will open up the land, spur development and ultimately benefit the country. That was the faith of those who originally proposed the highway. I think this "complex" lingers on but hopefully not in the minds of too many government planners.

A long time scale has to be used when you're planning for northern roads because you don't just create a physical pathway. Lawyers use the metaphor "opening up the flood gates" and it couldn't be a more apt expression in the case of highways.

There are some technical/legal problems with the land use regulations etc. but perhaps they can be considered in the discussion.

Discussion

STH I agree with most of what Bill has said.

MD The comments regarding the need for incorporating environment assessments into the planning stage are rather idealistic. I'm a little concerned as to how the system is working. For instance, what environmental assessment work would you want to have done if we were starting over with the Dempster? What kind of a structure do you think is needed to assure that full benefit is gained from the information gathered during the environmental assessment? How does it get back into planning?

There is such a wide range of environmental problems to deal with. For example, the issue of caribou and the Dempster. One can look at the behavioural aspects of caribou in relation to a development road. One can also discuss the likelihood that if the road goes ahead a certain percentage of the population will be lost. But I'm not sure that this information is really getting back into the planning, where it should be. Maybe the person doing work on caribou has a very strong interest in the species and is insisting that we can't afford to lose any caribou range.

Maybe I can get away from environmental considerations and look at the question of going to the native communities for their input. For example, had we gone to the village of Old Crow before the Dempster Highway was started some people might have said they did not want the highway because it was going to be detrimental to the caribou population upon which they are dependent for food. Yet if you read our local press you find that the people in Old Crow can hardly wait to get the highway developed to their community. So I think that the mechanism for putting these concerns together through planning is not well established. It is better to go thru this formal process but I'm not convinced that it is actual functioning.

It seems to me that after we got into the field of impact assessment, and the Dempster Highway was well underway, there were people wanting to know how many parasites every caribou and porcupine herd were carrying; there was no end to the detail that was wanted. It was very difficult to determine which of the so called impacts you should focus on. Which ones are going to be critical to the plan? Which ones are going to give you answers that are going to be useful in the plan? We could be studying caribou for the next 100 years and still not have all the answers that some people might want. I still think it all comes down to not really having the mechanism established for planning our assessment and for ensuring that the information we get during assessment will get back into planning.

PS Planning is a definite requirement but it does tend to take on a bit of the research picture. When you're a manager, you require information to manage, not for research. If, for instance, resource roads are built according to plans which take into consideration all environmental problems and which indicate how they can be resolved then the planning is effective. But if planning is going to stymie a project then it's not effective.

JM From this discussion it is assumed that the road will be built. One point Bill made is that if enough study is done and enough options are considered, then perhaps there are viable alternatives to the road. That's where much planning and research is required. There are ways to minimize impacts when building roads but some sort of impact must be accepted. In fact a "no-go" consideration is an option. Too many times the "no-go" option is not considered adequately. It's just assumed that the road is going to be built.

WM I have some sympathy with the manager who has been told by Cabinet that the road is going to be finished. There isn't much point for a man in that position to decide he's going to investigate whether the highway should not be built. He's got to work within the constraints that are imposed upon him. And when I say that you have to consider the no-go option, I'm speaking from a somewhat idealistic point of view. But I don't think we should let practical political constraints always limit our thinking as to what should be the right course of action. Lots of things happen in politics to change politicians' commitments to build highways. I think very few things are written on stone in political decision making. In conclusion, I wish to urge against the prevailing climate of opinion in the Yukon that says roads are sacrosanct in terms of development. There are other ways of developing the Yukon.

RB In the 60 Mile River area, EPS, Whitehorse is concerned about the fact that once you've built one resource road you may ultimately end up with a whole network of resource roads - unless you have an over-all land use plan. By putting one road in you open up the land and open up the resources for future development. If you're not careful you can get done to death environmentally, in small insignificant increments. There should be a more anticipatory approach to resource road developments in those areas.

CS If an area is going to be developed it's in the interest of government not to allow each application to essentially guide where they're going to permit future roads. Perhaps government should decide where they want the roads and then get the developers to work around those plans.

RB One planning technique which works is for government to indicate where applications will be favoured in advance of the opening up of a particular area; areas are identified where resource road development and developments of other kinds would be preferred from an environmental standpoint. Detailed environmental studies are not involved at this stage - it is planning at a regional scale eg. the 1:50,000 scale.

AH A difficulty we have in Saskatchewan with the theory of locating a road is that we don't always know where future resource developments will occur. If you're constructing a road you're looking at a fairly high capital investment, so you want to make sure that the road is fairly direct for the needs anticipated. Good planning certainly requires that if you have knowledge about other areas having resource potential in then you locate the road so that it will benefit them. Often, though, when a specific resource is identified it is the result of recent exploratory work. We're really not sure where the next resource location is going to be eg. the next mine. Therefore we lack the knowledge to locate the corridor, other than to route it in the most direct way possible to known resource locations.

EXISTING PRACTICE OF ENVIRONMENTAL ASSESSMENT IN THE DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

by

Peter Ferris

Within the Department of Indian Affairs and Northern Development, the Northern Program is responsible for implementing the Federal Environmental Assessment and Review Process. The process applies to projects that fall under the Territorial Lands Act, the Public Lands Grant Act, the Arctic Waters Pollution Act and the Northern Inland Waters Act. In other words, virtually all projects undertaken in the territories fall under E.A.R.P.

Project applications are made to the manager responsible for the relevant regulatory review. Managers encourage companies contemplating development projects in the Territories to contact the Department as early as possible to clarify the applicable environmental review requirements. This ensures that environmental factors are taken into account and that the screening process is initiated at an early phase in project planning.

When the information on environmental aspects of a project application is received by the Assistant Regional Directors, Renewable Resources, (Regional Offices) or the Director, Northern Environmental Protection Branch (Headquarters) they initiate the screening process. The "Guide for Environmental Screening" issued by Fearo is the basis for determining whether or not the project may have significant environmental impact.

Significant environmental effects are based on the professional judgements of the reviewers. Consideration includes factors such as: the intensity and extent of the effects, the extent of unique environmental elements that may be affected, the time required for rehabilitation, the socio-economic implications and the public perception of potential effects. Projects are not reviewed in isolation but are examined in the context of cumulative impacts.

The division of responsibility for environmental screening of projects by either Headquarters or Regional Offices of the Northern Program has been set down. Generally drilling programs, hydrocarbon production facilities, pipelines, and major transportation facilities are reviewed in Headquarters. Access roads, tote trails, mine expansion and placer mining projects are reviewed in the Yukon Regional office. Access roads tote trails, hydropower plants, water diversion schemes and mining developments are reviewed in the Northwest Territories regional office.

In headquarters, the Director of the Northern Environmental Protection Branch is responsible for the environmental screening. It is conducted by the branch with the advice of the Departments of Fisheries and Oceans and Environment and of the wildlife and the socio-economic Branches of the respective Territorial Governments.

The results of the screening and substantiated reasons for the decisions are recorded. A recommendation to refer or not to refer the project to FEARO for panel review is forwarded to the Director-General, Northern Environment.

In the regional offices, the Assistant Regional Director, Renewable Resources is responsible for the environmental screening. It is conducted by the managers responsible for the regulatory review and by the Regional Environmental Review Committee chaired by the Assistant Regional Director. As in the headquarters review, the results, the decisions and a recommendation to refer or not to refer the project are forwarded to the Director-General, Northern Environment.

The Director-General makes the decision to refer or not to refer the project based on the recommendation forwarded to him and on advice from the Interdepartmental Environmental Review Committee.

Projects not referred to FEARO are assessed within the department by the group that screened the project. Extra expertise and advice is used as required. The group is responsible for specifying environmental constraints that should be imposed on the project and passes them to the relevant regulatory groups for enforcement and monitoring.

Projects referred to FEARO are assessed by a panel through the public review process. The Department provides advice to the project proponent in preparing the documentation since the initiating department shares responsibility for the adequacy of the E.I.S.

When the Minister of DIAND accepts the recommendations of the Minister of DOE following the FEARO review, the Assistant Regional Directors of Renewable Resources and the Director of the Northern Environmental Protection Branch ensure that environmental terms and conditions are compatible with the Minister's decision. The terms and conditions are forwarded to the relevant regulatory groups for enforcement and monitoring.

The success of the implementation of EARP is enhanced in the Department by exchange of information between the proponent, headquarters, regional offices and the public at large. Open files on projects that have been reviewed will be established in Headquarters and the Regional Offices.

As noted earlier, the review of resource roads is the responsibility of the regional officer. However, headquarters staff often have an input to many of the smaller resource roads projects. The Northern Roads and Airstrips Division provides financial assistance for resource road construction and requests environmental advice when applications for such assistance are received. Under these conditions both headquarters staff and regional staff provide input to the process.

From my experience with the Mackenzie and Liard Highways and with resource access roads assessment, I have noted several problems.

The first problem - the timeliness of noting environmental concerns - spells the difference between being able to achieve a high standard of environmental design and applying band-aids to open wounds. If environmental awareness is present during project design, before the first line is drawn on the map, the whole process improves dramatically.

The second problem - correct installation of culverts for fish passage - has improved substantially. I personally feel that installing the culvert invert below the original streambed and stabilizing the inlet and outlet is the number one improvement in improving chances for fish passage. Inherent in this, is the need to maintain the original stream slope as much as possible.

The third problem - erosion control at or near stream crossings -becomes more important in poor soil conditions such as are encountered on much of the Liard Highway. The critical aspect of this problem, I think, is not the erosion associated with spring runoff when the streams often carry a high natural sediment load but the continuing erosion throughout the year. This becomes more critical where important fish spawning and rearing habitat is in the vicinity of the crossing.

The fourth problem - improved access to areas for hunting and fishing -is often glossed over. I've often heard the phrase "Oh that's a management problem" when we raise this concern. While the point is true, I think we need further effort to coordinate the capability of the human resources to manage the improved access and the ability of the developers to provide the access.

Discussion

JM Is your screening process proposed or is it in effect? I don't think that placer mines are being assessed in a formal manner at this time.

PF It's being used in various projects. In the case of placer mining it is being studied as a special project. They've apparently finished the first phase and a lot of biological work has been done in the past year.

JM What about the roads associated with placer operations?

GZ I think there's a formal environmental review where the Department of Fisheries and Oceans is asked to provide input on certain roads but not for each individual application. We do have an opportunity to review projects through the plans committee and to comment on each actual claim as it is brought into production. But we don't seem to work much on roads. The focus is more on general access and the actual placer mining operation itself.

JM Is there going to be a screening report for every project and will it be on open files?

PF That is what's envisioned. But at the moment it is under discussion with the people in our Branches.

WM Has anything like this been applied to a specific project?

PS No, but we had sub-committees set up with different government agencies involved on impact assessments. Specifically, there was one for St. Joseph's but since the company is re-evaluating its financial picture, the subcommittee is inactive. There's another one being put together for Iona Silver.

AH Just a few points, from my experience in Saskatchewan. All road projects deemed to have any significant environmental impact go thru a screening committee. The proponents are required to file a proposal. On the basis of that proposal the screening committee consisting of a group under the chairmanship of the Department of the Environment, reviews the project from a biophysical as well as a socio-economic point of view. On the basis of that review, proponents are allowed to proceed with the road once an advertisement has been placed in the newspaper advising the public that a decision has been made and that information is available. As well, if the road is deemed to have some environmental impact, the proponent is required to prepare an environmental impact assessment for that project.

JM I support Peter Ferris' comments on building roads with regard to providing fish passage and installation of culverts. In my opinion it does'nt cost much more to install a culvert in a way that will pass fish rather than put it in so there's a two foot jump at the end. We have guidelines from the Vancouver office and from fisheries in Winnipeg on construction of culverts.

While fisheries studies are important, in many cases it takes a long time to find out where the fish are at particular times etc. and if consultants do a survey and don't find fish there's always criticism. People will say they didn't do the surveys at the right time of year.

CS Fish monitoring can cost a lot of money. If you happen to hit the wrong month or spring comes a little early the fish may already be gone.

JM Fisheries studies are set up generally as a one shot effort. It's a valid criticism that they are not done over a long enough time period. They may spend 3 or 4 weeks and the conclusion that there are no fish in the stream is not necessarily accurate given this time frame. You might just as well go ahead and make the assumption that there are fish there and design for it.

PF The land use permit stage is one of the points where a proponent must consider environmental concerns. We would hope that before a company gets to the land use permit stage, though, that environmental concerns would be known. If not, the company may have to back-track to obtain required information. As soon as the Northern Roads and Airstrips Division gets an application for assistance to build a tote road etc. then we are notified. That gives us a chance to identify general problems that the company should look at when they try to develop their project. Then we go to the territorial governments and our regional offices and look at it in more detail as the project develops.

WM Is there any advantage to doing the work you do in Ottawa, as opposed to doing it in the North? One disadvantage is the difficulty for you to get into the field to see the roads that people are concerned about.

PF It's costly for me to get out into the field because of travel distances. Most of the resource roads that involve a small area are handled by the regional office. Headquarters staff look at major projects of national concern, for example, projects that involve the two territories. Regional staff will also be involved in these projects as well.

My work is done in Ottawa because Senior government officials are there and we feed them the information we get from the regional offices and put it together to make recommendations. Also, in Ottawa, political considerations are dealt with. The bigger the project, the more this becomes important.

WM I appreciate your explanations but it still seems to me that for the most part it would be better if road planning were done in the north. Political decisions that are required could be made on the advice of people who fly from the regions to Ottawa. It seems to me that to have things run from Ottawa is to create difficulties for yourselves.

CS The fact is that the Government is in Ottawa. It's absolutely necessary to have somebody there on a day by day basis to advise senior officials. They're the ones who make the decisions and a lot of their decisions are based on gut feel. If you can't influence that in some way your chances are pretty slim of getting things done the way you want. If all of the work was done in the North and they were sitting in Ottawa getting the odd phone call and letter we'd be in worse shape than we are now.

WH The fundamental question Bill is addressing is the fact that the people who run the Yukon do not live here. The Yukon is a "wholly owned subsidiary" of the federal government and until that situation changes, I can't see anything changing in this process. It's a very large political question.

PS It has been suggested that the North Canol road is going to be reconstructed. Is there any thought of this being studied, knowing the limited time frame that's involved? If so, is it going to be done in the same way as the Shakwak or the Dempster or will it be treated as a mining resource road?

WH There was a meeting of the MacMillan Pass task force last week with 3 or 4 of the major industrial proponents and various levels of the federal and territorial government in attendance. It was agreed that the federal and/or territorial government would look after the overall environmental review and establish guidelines on the kinds of information each proponent should supply for his particular area. It appears that the overall review will be the responsibility of government.

JM Have we decided yet what government?

WH They're trying to co-ordinate things so that we don't get three different people doing the same studies in industry and in government. That seems to me to be a reasonable approach.

STH Would this be the EARP process?

WH They don't know if it will go that way or not. It has to be screened yet.

MD We've apparently lost completely the ideal of building into planning a go, no-go decision on projects. With regard to the St. Joseph's operation, we've been talking about fish passage but who made the decision whether that road should even go ahead?

PF I don't think anyone has made the decision that that road should go ahead. But when the project came thru and the company said what do we have to do in environmental terms, this was one of the things that they put together. But as far as I know there hasn't been a decision as to whether that road is to go ahead. They have provided us with an environmental evaluation that will be reviewed.

MD But we're going to assume that the decision as to whether or not the road is to go ahead will be based on a review of that assessment. If there are no significant impacts or the impacts that are identified can be handled then presumably the project will go ahead. But that does not take into account a regional planning concept. One of the features of that area are the Cold River Springs. Perhaps we're not in a position to want access to the area at this time because of this fact. I think we're right back to the Dempster Highway situation.

PF The Cold River Springs were mentioned in the report. The company is aware of it and took the Springs into account in their planning. This underlines the importance of getting the environmental concerns in there first. They have to consider the possibility of the Springs becoming a tourist area so they're trying to keep the road away from that immediate area. You do not want mining trucks running up and down the middle of the springs. So I agree, there should be more regional planning. In the case of the Howard's Pass access road we identified environmental concerns at the proposal stage but it was terribly difficult, if not impossible to get information as to where the company was to haul ore i.e. whether it was going to come down that access road or whether it was going to go north to the Canol road. That whole region could have been looked at from a regional planning perspective. Various deposits were known.

MD If somebody wants to use a winter access road, we tend to say that's a minor operation. It's not something that has to go through EARP. Yet the fact is, they become accepted roads. The Rusty Springs Road off the Dempster Highway provides an example. When that road came up it didn't go before EARP. Presumably if that property is developed it would be very difficult to start looking for other routes, especially if it was going to cost the company more money. There's already a good foot in the door there.

ENVIRONMENTAL DESIGN ON THE SHAKWAK PROJECT: STREAM CROSSINGS, BORROW PITS AND CAMPS

by

John Hudson

I'd like to deal with some practical ways of taking heed of environmental concerns. My paper deals with the Shakwak Project, which is the reconstruction of approximately 520 kilometres of the existing Haines road and the Alaska Highway north of Haines Junction. The project is unique in that it's totally U.S. funded. Because of U.S. regulations this project ran the full gauntlet of the Canadian EARP process and by doing that simultaneously met the environmental requirements of the U.S. Government. We had public hearings, preceeded by information hearings. The parties involved in the hearings went to Haines Alaska, Haines Junction, Destruction Bay, Burwash, Beaver Creek and Whitehorse. The EARP panel's findings were simultaneously sent to the U.S. Government and the Minister of the Environment. In June 1978, joint approval to proceed was received from both the Minister of Environment and the U.S. Government.

What I'm going to present today is not innovative or new. It is merely the practical application of what's been known for years. My presentation is going to rely heavily on design input by our landscape architect. He was available on site. The first subject I'd like to discuss is treatment of right-of-way. Several sub-aspects are involved. In the past, it's been the practice to clear a standard width of 200' to form a symetrical right of way that encompasses a lot more land than is needed. The advantages are that it reduces the risk of hitting game and allows the sun to get at the road to remove frost and snow. The negative aspect of the wide right-of-way is that it eventually grows back or has to be cleared regularly. The Shakwak project adopted a cleared right-of-way between 7 & 9 metres wider than the road prism and varied the clearing width. Rounding of back slopes helps to blend the road smoothly into the surrounding countryside plates 1, 2, 3, 4. The new widened

PLATE 1 SHAKWAK PROJECT, HAINES ROAD, Y.T., KM. 240. OLD BORROW SITES RECLAIMED, SLOPES DRESSED WITH CUT SLOPE ROUNDING MAKING ROUND PERIPHERY MORE AESTHETICALLY PLEASING

PLATE 2 SHAKWAK PROJECT, HAINES ROAD, KM 244. RIGHT OF WAY CLEARING WIDTH IS VARIED TO CLEAR ONLY THE ROADWAY PRISM PLAN 7-9 METRES ON EACH SIDE. NOTE CUT SLOPE ROUNDING.

PLATE 3 SHAKWAK PROJECT, HAINES ROAD, Y.T. OLD BORROW SITE DRESSED UP. STEEPER SLOPES ARE HYDROSEEDED TO DISCOURAGE EROSION AND RETARD IMMEDIATE TREE ENCROACHMENT INTO THE CLEARED RIGHT OF WAY SEEDING OF OTHER AREAS IS TO BE DONE LATER.

PLATE 4 SHAKWAK PROJECT, HAINES ROAD, Y.T., KM 249. RIGHT OF WAY SIDE BORROW SLOPES FLATTENED AND CUT TOPS ROUNDED. STRIPPING WASTE MATERIAL CARRIED BACK DOWN SLOPE TO ENCOURAGE REVEGETATION.

right-of-way encroached on some other utility or pipeline rights-of-way and this would have left a thin stand of trees between the two facilities. As there were no other trees supporting them they would have eventually fallen over Plate 5. These trees were removed to prevent dead fall. At several points along the highway, Parks Canada, the Land Use Group and our landscape architect identified areas of scenic beauty. Pulloffs were provided Plates 6, 7.

I will now discuss borrow pits. We were required, insofar as there were trees in an area, to leave a tree screen between the right-of-way and the pits Plate 8. Where there were no trees we were asked to blend the pits into the surrounding countryside by carefully planned borrow. Road access has been screened from the right-of-way as well Plates 9, 10, 11. We're required to slope pit slopes to 2 to 1 when the pits are closed. The topsoil is leveled off and smoothed down the slopes. Care must be taken not to spread the topsoil too thinly or it will be of no practical use Plates 12, 13.

I will now discuss culverts. If there is a danger of bank erosion or silting of a stream, all clearing is done by hand in the vicinity of creeks Plate 14. Grubbing is not performed at all. For example, at Summit Creek just north of MacIntosh lodge a fish population was identified which had been attempting, unsuccessfully, to migrate thru a culvert, probably since it was installed during the Second World War. So a plunge pool was provided at the bottom end of the culvert by installing a small rock weir. This effectively backwaters the culverts to permit fish access up thru them. This has application in relatively small culverts of about 36" diameter Plate 15. Also used was a stream bed which was graveled by design and the culvert sunk below the bottom to duplicate the natural stream bed. Rocks provided numerous eddies as well as slow moving currents to assist fish passage Plates 16, 17, 18.

Another problem which was dealt with was icing up of culverts. This causes danger to the public and great expense to maintenance people. Active solutions like steam maintenance and electric cables are costly, time consuming and often ineffective. We obtained a passive solution

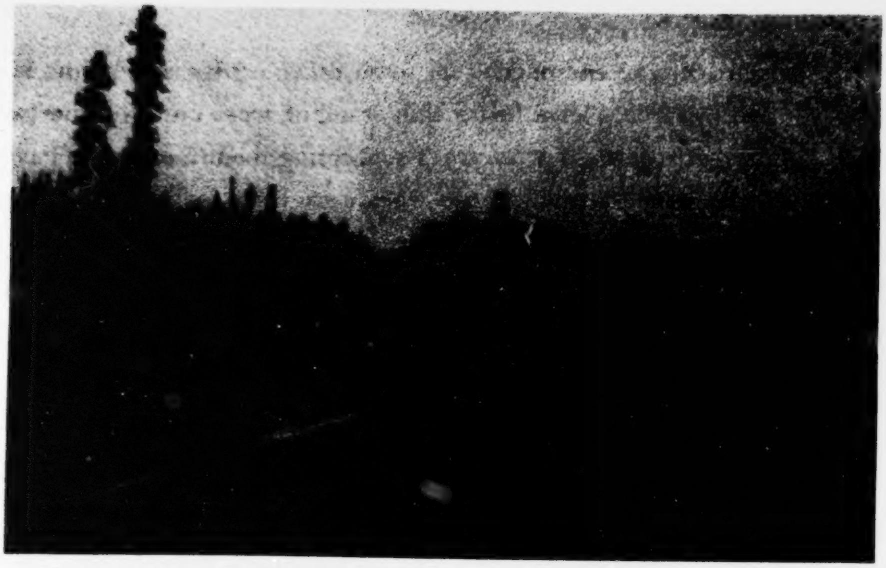


PLATE 5 SHAKWAK PROJECT, HAINES ROAD, Y.T., KM 247. WHERE UTILITY RIGHT OF WAY AND HIGHWAY RIGHT OF WAY LEAVE A VERY THIN TREE SCREEN SUBJECT TO WIND FALL, LANDSCAPE ARCHITECTS INPUT RECOMMENDED SELECTIVE ADDITIONAL CLEARING.

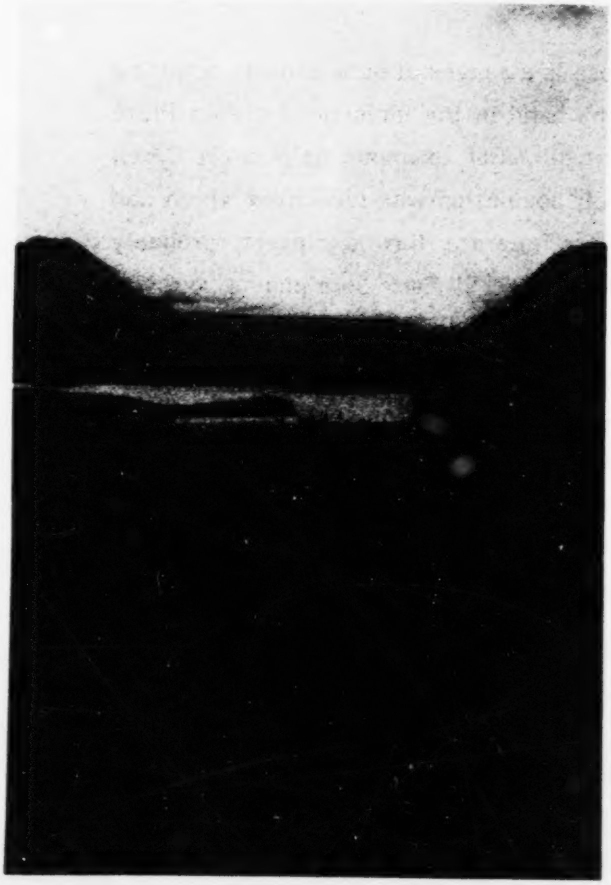


PLATE 6 SHAKWAK PROJECT, HAINES ROAD, Y.T., KM 235. KATHLEEN LAKE VIEW-POINT. A PULL OFF WITH A VISTA OF KLUANE NATIONAL PARK. RECLAIMED LAND ADJACENT TO THE HIGHWAY AT THIS POINT ALSO MEETS TOURIST NEEDS.

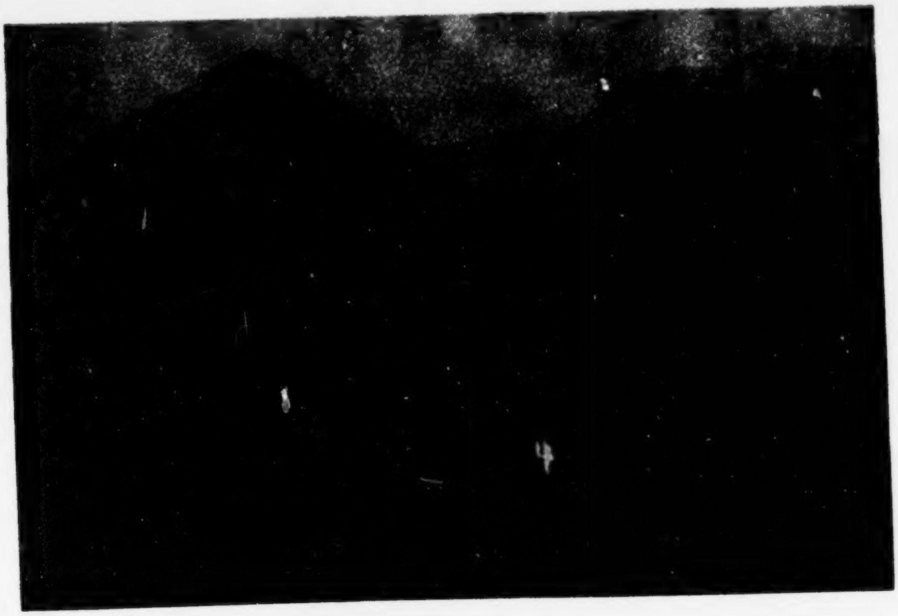


PLATE 7 SHAKWAK PROJECT, HAINES ROAD, Y.T. KM 235. AS PER PLATE 6, BUT IN AUTUMN.

PLATE 8 SHAKWAK PROJECT, HAINES ROAD, Y.T., KM 224. VIEW FROM HIGHWAY LOOKING INTO A TREE SCREEN HIDING A GRAVEL PIT.

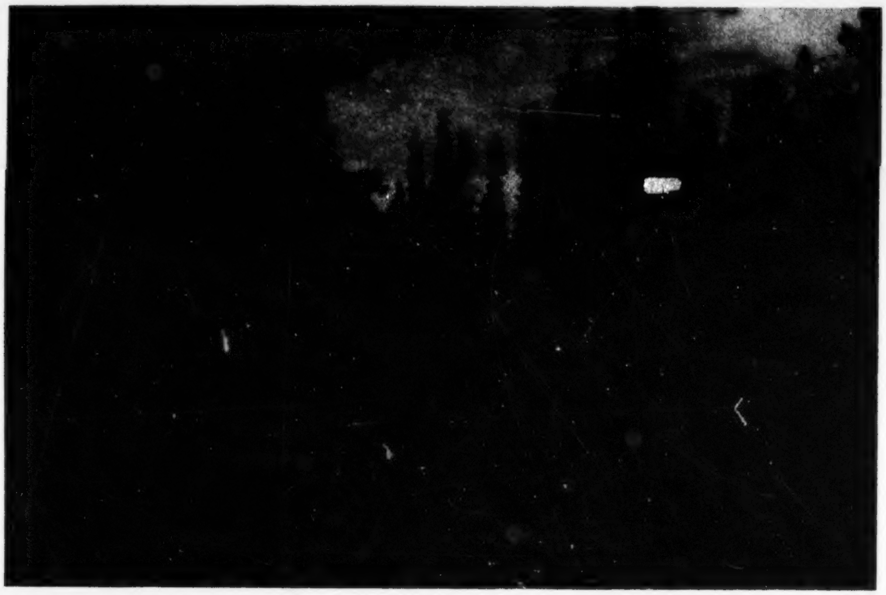


PLATE 9 SHAKWAK PROJECT, HAINES ROAD, Y.T., KM 228. ACCESS ROAD INTO A BORROW PIT IS DOG-LEGGED TO HIDE PIT. PHOTO TAKEN DURING CONSTRUCTION. ROAD WILL BE DRESSED UP LATER SO IT WILL BLEND INTO THE SURROUNDING TERRAIN.

PLATE 10 SHAKWAK PROJECT, HAINES ROAD, Y.T., KM 224. ACCESS TO TWO ADJACENT PITS, VIEWED FROM HIGHWAY. THE PITS THEMSELVES ARE COMPLETELY HIDDEN.

PLATE 11 SHAKWAK PROJECT, HAINES ROAD, Y.T., KM 246.6. VIEW FROM HIGHWAY INTO PIT ACCESS. PIT COMPLETELY SCREENED.

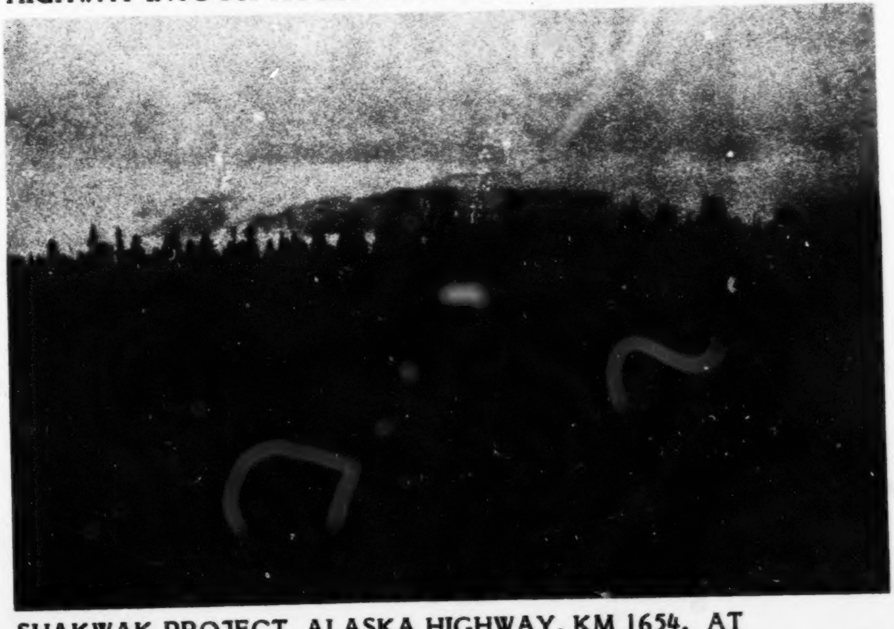


PLATE 12 SHAKWAK PROJECT, ALASKA HIGHWAY, KM 1654. AT COMPLETION OF BORROW EXCAVATION, PIT SLOPES REDRESSED TO 2:1 OR FLATTER AND WASTE MATERIAL IS LEVELLED OR SPREAD OVER PIT FLOOR. ALL CLEARING AND GRUBBING DEBRIS HAS BEEN PREVIOUSLY BURNT.

PLATE 13 AS PER PLATE 12.

PLATE 14 SHAKWAK PROJECT, HAINES ROAD, KM. 214. A FISH CREEK. MACHINE CLEARING AND GRUBBING HAS BEEN STOPPED 5 METRES SHORT OF SUCH CREEKS TO PREVENT BANK EROSION AND JETATION. CLEARING HAS BEEN PERFORMED BY HAND.

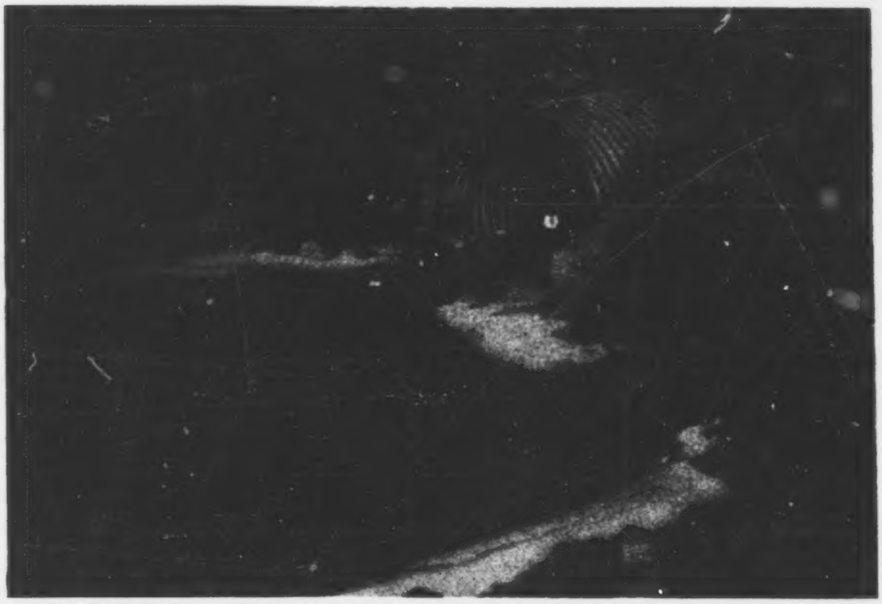


PLATE 15 SHAKWAK PROJECT, ALASKA HIGHWAY, KM 1646. SUMMIT CREEK, FISH STREAM AND MIGRATION ROUTE. STEEP STREAM PROFILE HAS BEEN REDUCED WITH A SMALL PARTIAL WEIR WHICH CAUSES A BACKWATER TO THE CULVERT AND THUS AIDS FISH PASSAGE.

PLATE 16 SHAKWAK PROJECT, ALASKA HIGHWAY, KM 1639. INLET TO PINE CREEK. MULTI-PLATE PIPE ARCH CULVERT, LINED WITH 0.6 METERS OF GRAVEL TO PROVIDE A NATURAL BOTTOM FOR FISH.

PLATE 17 SHAKWAK PROJECT, ALASKA HIGHWAY, KM. 1639. MULTI-PLATE PIPE ARCH CULVERT AT PINE CREEK. RIP-RAP IS 0.6 METERS ABOVE PIPE INVERT, THUS PREVENTING WASHOUT OF THE 0.6 METERS OF GRAVEL WHICH LINES THE CULVERT INVERT.

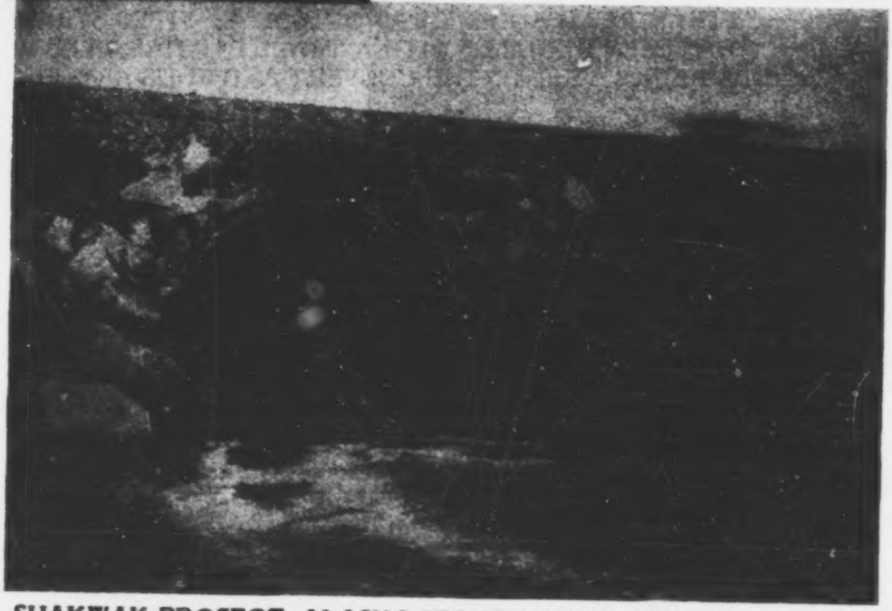


PLATE 18 SHAKWAK PROJECT, ALASKA HIGHWAY, KM. 1639. AS PER PLATE 17. AT THE RIGHT OF THE PHOTO THE RIP-RAP APRON IS LAYERED SO THAT A DEPRESSION IS FORMED ALLOWING A PLACE FOR FISH TO REST.

from the U.S. Department of Highways, Alaska. It involves catch pools at the upstream and the downstream end of the culvert Plates 19, 20, 21. These are rock lined to collect the water filtering thru the rock. Between the two pools is an underdrain (culvert) which is insulated on top. The water percolates into the rock which is insulated by a snow layer lying on top; the water passes thru the underdrain and escapes by similar means out the other end. This way icing is minimized. The main culvet is going to carry the summer water. This design has worked for two years and we have done away with costly steam maintenance practices.

At Seltat Creek we were faced with an area with 80 feet of fill over a stream that was fish bearing. We achieved fish passage thru a culvert by making one of the two passages of the concrete box culvert a fish passage with fish baffles. A weir structure directs all the water through the fish passage during low flows. By this means we get fish passage with low flows and at high flows water will go thru both barrels Plate 22.

We placed all our camps at existing road maintenance camps and pump stations along the Haines Road and the Alaska highway. The camp facilities were supplemented with trailers and bunk houses. To prevent wildlife encroachment on the camp we used fencing. All camp garbage was retained in a cage to avoid problems with birds or dogs prior to it's daily incineration in oil fired incinerators Plates 23, 24, 25, 26.

Discussion

JK We have run into a problem in the Yukon with the closing of borrow pits. There's apparently a need on the part of highway maintenance people to have continued access to gravel resources for upgrading roadways so we have hundreds of these borrow pits left unreclaimed in the Yukon I'm wondering how you were able to close borrow pits on this project?

JH There is a requirement for 3 to 4 inches of new surfacing material every 3 to 4 years to replace what is thrown off into the bush as the road gets travelled. With a reconstructed highway that is paved, the need for borrow material is greatly reduced after construction is completed. The

PLATE 19 SHAKWAK PROJECT, HAINES ROAD, KM 252. UPSTREAM POOL OF UNDERDRAIN INSTALLATION TO ALLOW PASSAGE OF WINTER RUN-OFF IN SPITE OF GLACIATION. A ROCK LINED POOL ALLOWS INFLOW OF WATER BENEATH THE ICE LEVEL. WATER IS PASSED BY AN INSULATED, SUBMERGED SMALL CULVERT AND ROCK FILTER UNDER THE HIGHWAY AND INTO A SIMILAR ROCK-LINED POOL AT THE DOWN- STREAM END. EXTRA SUMMER FLOW CARRIED IN A LAYER PIPE INSTALLED AT THE NORMAL GROUND LEVEL.

PLATE 20 SHAKWAK PROJECT, HAINES ROAD, KM 252. AS FOR PLATE 19. UNDERDRAIN AT GLACIATING CREEK OUTLET POOL.

PLATE 21 SHAKWAK PROJECT, HAINES ROAD, KM. 252. AS FOR PLATE 20. UNDERDRAIN AT GLACIATING CREEK, OUTLET POOL IN SPRING TIME, STILL WITH PARTIAL ICE COVER. INSTALLATION HAS WORKED SUCCESSFULLY FOR TWO WINTERS WITH NO MAINTENANCE. IN FIVE YEARS THE UPPER POOL MAY REQUIRE SOME GRAVEL REMOVAL.

PLATE 22 SHAKWAK PROJECT, HAINES ROAD, B.C., KM. 86. SELTAT CREEK INLET SIDE PARTIALLY COMPLETE. FISH BAFFLES WILL BE INSTALLED IN ONE BARREL OF CULVERT. A LOW CONCRETE WEIR WILL ALSO BE CONSTRUCTED NEAR THE INLET TO INCREASE THE VOLUME OF WATER THROUGH THE FISH BARREL.

PLATE 23 SHAKWAK PROJECT, HAINES JUNCTION CAMP, ALASKA HIGHWAY, KM. 1649. OIL FIRED INCINERATOR USED IN ENGINEERING CAMPS. GARBAGE WAS BURNT DAILY.

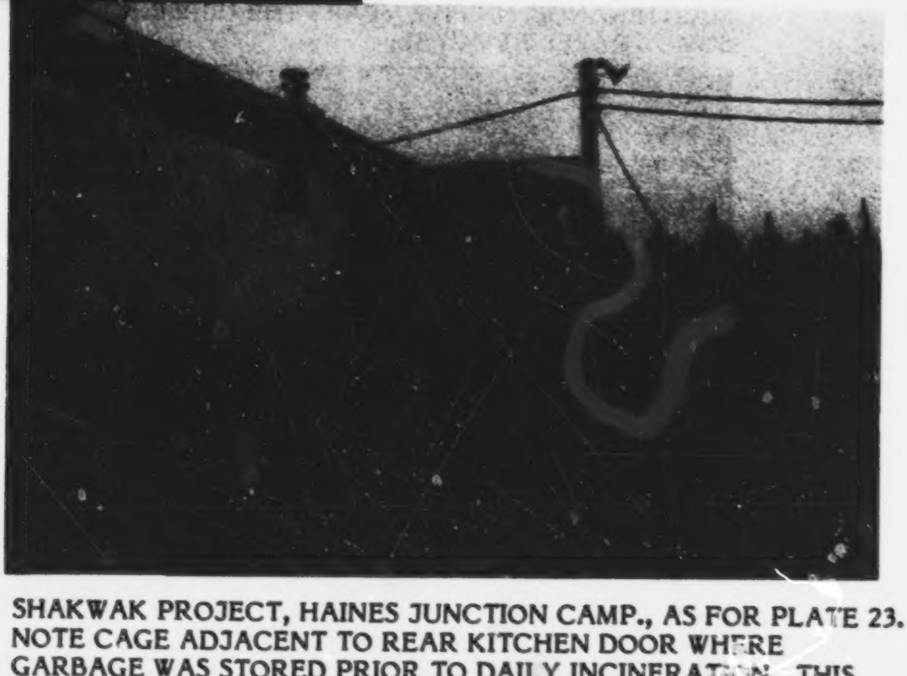


PLATE 24 SHAKWAK PROJECT, HAINES JUNCTION CAMP., AS FOR PLATE 23. NOTE CAGE ADJACENT TO REAR KITCHEN DOOR WHERE GARBAGE WAS STORED PRIOR TO DAILY INCINERATION. THIS PREVENTED GARBAGE BEING SPREAD BY WIND, BIRDS AND ANIMALS.

PLATE 25 SHAKWAK PROJECT, HAINES JUNCTION CAMP, AS PER PLATE 24. CAMP GROUND AT EACH CAMP WAS FENCED, AS SHOWN HERE TO DISCOURAGE VISITING WILDLIFE.

PLATE 26 SHAKWAK PROJECT, RAINY HOLLAN CAMP, HAINES ROAD, KM. 77.

requirement for further gravel on the Shakwak should be limited to 1 inch every 10 to 15 years, depending on how long the pavement lasts.

JK Do you find that a certain percentage of these pits, 1 out of 3, or 1 out of 10, or whatever, have to remain in service for that additional work?

JH At the closing of each project we discuss with the territorial government highways, (based on reviews of the pits and based on their needs) which ones we will leave open and which ones we will close.

JM I understand you had an environmental co-ordinator on the job, a Mr. Spencer. Could you comment on how you felt that position worked out.

JH It was necessary at the Projects' conceptual early stages to have an environmental co-ordinator to coordinate the mass of environmental work, including the setting up of monitoring. He was needed also for developing site specific guidelines for the Project, for use by the resident engineers at the conceptual design stage, contract preparation stage and the contract administration stage. Mr. Spencer was steadily working himself out of a full time job. Public Works Canada now has a regional environmental coordinator who has been committed to coming up frequently during the construction season to continue Mr. Spencer's work on contract monitoring. I'm in discussion with him on various aspects of the work on an almost bi-weekly basis.

BM Is he an engineer or a biologist?

JH He's a biologist.

CS When you're sloping borrow pits have you had any opportunity to develop wildlife habitat in these areas?

JH We pick up most of our excavation material in the right of way. I don't approve of taking out great swaths because when the area is revegetated and reseeded it will probably attract wildlife to the highway right-of-way. That is undesirable because if you run into a horse, moose or a cow in this country the driver is at fault. If you can't get enough material from the right of way then you should develop pits away from the right away with a tree screen.

CS We've just finished a job with the CNR and one of our major concerns was to make the area unattractive for game along the right-of-way to keep them from being killed. If you do have pits away from the road it would be a positive approach to make those areas attractive to game. Along the road you could seed with species that were not so palatable to animals to encourage them to go elsewhere for their food.

JH We are committed to revegetating erosion prone slopes. The grass seed we're using is designed specifically to retard the return of spruce, willow and poplar into the right of way. This is to avoid continued disturbance by Y.T.G. maintenance crews who follow a "scorched earth" policy. Some grass feeding animals will be attracted to the right-of-way but that's unavoidable. It's a "no win" situation.

CS With all due respect to those who maintain that the environment is being destroyed by roads, invariably when a road is built the animals are attracted to it. In fact, you're creating better habitat than was there before. If you set back plant succession you are going to create an excellent environment for a lot of wildlife species. They are attracted to these areas. The real problem, in my view, is the danger of over-hunting due to improved access.

JK It's difficult to point to improved forage as a benefit to wildlife when you greatly increase hunting pressure, especially from native people.

CS We need land use planning that includes wildlife habitat management and people management and this is what we're not getting. What the wildlife managers are faced with is the reality that there is no habitat management and no people management at the level necessary to preserve wildlife populations. The real habitat managers are agriculture, forestry, the highway departments, and the pipeline builders. They manage habitat and therefore they manage wildlife, but mostly by accident.

PF A practical example of what you're talking about can be found on the Liard highway between the Mackenzie highway and the Poplar River culvert. There are a lot of borrow pits close to the road and many people might feel they are an eyesore. Yet most of those borrow pits are filled with water and have improved the habitat for waterfowl in the area.

MD Why is it not a good place for the borrow pits to be? I'm a little disturbed that we seem to want an environment devoid of wildlife along the right-of-way.

JH A point I would like to mention is the cost of providing culverts to pass fish. The cost of not producing a two foot drop and putting in the right grade is negligible. However, the cost does become very large if you want to pass fish by oversizing the culvert diameter. If you increase the diameter you've got to increase the gauge and you pay for raw steel by the pound. Increasing the culvert to pass fish as opposed to passing the 15 or 25 year storm may increase the cost two or three times.

JM Did you actually come up with the dollar cost on this oversizing?

JH The cost increases for providing fish passage could be in the order of 2 to 4 times.

JK Is there a reduced maintenance cost on these larger culverts? It's my impression that the smaller culverts tend to get plugged up much more frequently.

CS I know of one instance in the Yukon where maintenance crews would go out about once a year with a bulldozer. They'd plow dirt into the creek to block it off so they could work on the culvert. Then they would leave the dirt in the creek.

GM I'd like to get back to the extra cost of big culverts. You say, John, that for one particular culvert it may cost 3 or 4 times as much as a smaller one that would not pass the fish. In the case of the Shakwak highway, or any other highway, how many of these big culverts are you going to need? If there's only say two in a hundred mile stretch, the extra money is surely quite insignificant.

JH You may be right when looking at the overall project, but as construction managers we've got to look at the small costs as well as the large ones.

GZ When these roads are pushed into an area, we end up with a lot of additional costs in the maintenance of the road, enforcement etc.

AH John, I noticed on the Shakwak project you had 100% brush disposal, is that a normal procedure for all of your resource roads?

JH Generally on our resource roads we burn when it's not convenient to bury under the center of the road. Push piles are a thing of the past.

AH Saskatchewan hasn't gone to total brush disposal. Our government cancelled push outs as a means of disposal but on a recent project that we were doing on an Indian Reserve, EPS directed us to go to push outs.

CS I think you should use hydro axes and eliminate the need for burning. It's like an enormous lawn mower. It takes trees and turns them into match sticks. We tried it in the muskeg in the Cold Lake area and even during the spring thaw we were able to go in there and knock down 50 acres of bush and grind it to a pulp without disturbing the surface layer. It's a little more expensive than burning but you eliminate 2 or 3 other steps.

PS We burn in this country because the low precipitation and the flammable materials do not break down quickly. Our fire control people are very concerned when disposal is not by burning because it creates a forest fire hazard.

RESOURCE ROADS
CONCERNS OF THE YUKON CONSERVATION SOCIETY

by

Sandy T. Hobus

The concerns of the Yukon Conservation Society with respect to resource roads focus primarily in the areas of:

a) the land use permit granting system
b) the lack of overall land use planning and subsequent policy on roads
c) the Northern Exploration Facilities Program

A. The Land Use Permit Granting System

The Conservation Society feels that problems related to the proliferation of resource roads and subsequent unnecessary environmental damage stems from inadequacies within the land use planning and permit granting system. We sight the following inadequacies:

1) The lack of a comprehensive land use policy means that other legitimate land uses such as trapping, outfitting, recreation and guiding are considered to be inferior to that of the mining industry.
2) Inadequate notice for review (10 days) to other land users in the area, interest groups and the public in general.
3) One hundred percent of all land use permits are granted. The no-go option is never seriously considered.
4) No mechanism exists to deal with the status and jurisdiction of roads once a project is complete. i.e. no one determines whether a road should stay open or should be closed and under what conditions.
5) The permit system does not have control over roads cut on leases and claims.

B. Lack of Overall Land Use Planning and Subsequent Policy on Roads

Due to the lack of a comprehensive land use planning and subsequent policy on roads, a variety of subjects remain unaddressed:

1) Standards for road construction
2) Environmental reclamation

3) Increased use of winter roads
4) The need for terrain analysis prior to the issuing of permits (including wildlife habitat, vegetation and soil)
5) Determination of criteria for appropriate siting for present and future use.

C. Northern Exploration Facilities Program

This program raises the public policy issue of subsidization of industry. The Government of Canada appears to favour the form of tax deductions for industry as exemplified in the National Energy Program and Bill C-48.

The Tote Road Assistance Program, or as it is now called, the Northern Exploration Facilities Program, should be repealed and either incorporated into a more sophisticated scheme of government subsidy or done away with entirely for it can be misused and abused in its present form. The program is predicated on the principle of providing access to mineral deposits yet there is no requirement for industry to prove minerals exist (or even a high degree of certainty).

If one accepts that land uses other than mining are legitimate, then this program should be broadened to include trappers and outfitters who wish to put in an access road, horse trail, etc.

This program reflects the philosophy that mining is a top priority land use. The testimony heard on the Yukon Minerals Act in the early 1970's witnessed a lobby on behalf of the mining industry strong enough to have the Bill withdrawn and never reintroduced. Until a land use planning system and policy is developed that gives serious consideration to land uses in addition to mining, resource roads will continue to be built for political reasons. The Dempster Highway is a resource road that exists for purely political reasons - certainly not for an economic or environmental rationale.

Additional Reference:

McTaggart Cowan, Ian, "Some Environmental Considerations in the Planning, Construction and Maintenance of Northern Roads with Relevance to the MacKenzie Valley Highway", Canadian Environmental Advisory Council.

Copies can be obtained through the Canadian Environmental Advisory Council, Department of the Environment, Fontaine Building, Ottawa, Ontario, K1A 0H3.

Discussion

GM I agree, there's a lack of teeth in the law. I know of several instances where oil companies started construction of large gas plants after they had applied for a permit, but before any government department had any chance to review the application, because they knew that the application would be approved. With that kind of situation there doesn't seem much point in having any laws at all.

STH We've only got 10 days to react, and if the notice is mailed, then the time may be up before an outfitter or trapper gets it.

BM I have a question for Perry Savoie. Since trappers are affected by those who get land use permits, has anyone considered whether, as a term of the land use permit, the developer could be made to come to an agreement as to compensation for the trappers. This is a term that is put into water licenses such that a person has to come to agreement as to compensation for those that are affected by what he does. Couldn't the same principal be applied to land use permits?

PS I suppose it could but who would set the compensation and for how much? I don't know how the system could be worked out.

GM Suppose you've got a situation where a mining company wants to do something that will ruin a trap line and suppose the trapper just wants to be a trapper? What do you do then?

PS As I understand it, you can get compensated for improvements on the trap line eg. line cutting, trail cutting, cabins, line cabins, these type of things. To my knowledge, there has never been a compensation for loss of fur in this country.

BM In the James Bay agreement, there is an extensive system of compensation for trappers who's lines were affected by the project. If you don't give compensation to affected trappers you're saying that their trap lines are worth nothing and that's what they get now, nothing. So I say that it's better to give them something even though it might be hard to put a number on it than to give them nothing which is what they get now.

AH In a lot of cases the resource road assists the trapper by giving him access. So the fact that we're not paying compensation doesn't mean a value of zero is put on the trap line. In northern Saskatchewan we've had no requests for compensation from trappers. If you really get down to it, the trapper is happy to have the access.

PS I would like to ask Sandy to indicate whether she is talking about all kinds of mining access roads from the smallest operator to the largest, or whether there is one specific type of road she is concerned about.

STH The initial focus has to be on tote roads. Like a pebble in the water they just lead to bigger things. A lot of the large roads up here started as a track in the bush and then a tote road. The problem seems to come at the very beginning when the first permit is issued. A winter road does not necessarily do that much damage but it does cut a swath thru the bush and that can be followed later by something else. The argument to place a road or a pipeline there is a strong one - the access has already been provided so why go somewhere else and damage a new area?

Also, once a resource road is built under the northern Exploration Facilities Program, it is considered to be a public road and is the property of the Yukon.

JK A lot of resource roads are being built in the Yukon and we've got very few producing mines as a result. There has to be something wrong with the assumption that all of these roads are being built for a return, especially to the taxpayer who is subsidizing their construction. Where is the return?

GM That would come down to cost accounting. When a good cost accountant get's together with a good geologist they can figure out whether or not the gamble of putting the road in is worth it. I suppose if the mining companies think it's worth it, they'll go ahead. If not, they'll just walk away.

ENVIRONMENTAL ASSESSMENT OF ROADS IN NORTHERN SASKATCHEWAN

by

Andy Horosco

The Department of Northern Saskatchewan was created in 1972 to provide single agency government to the northern part of the province (Plate 1). Since its inception, the department has assumed most, but not all of the responsibilities of government in northern Saskatchewan. Transportation is one area in which jurisdiction is shared with other departments. The Department of Northern Saskatchewan, through the Roads and Transportation Branch of Project Management Sector, constructs community and resource access roads. Since 1973, the department has built a number of community and resource access roads, including the Stanley Mission road, Deschambault Lake Road, Pinehouse Road, Patuanak access road and the Southend Causeway (Plate 2). At the present time the department is working on a road to Dillon, a road between Pinehouse and Beauval, improvements of a road between Uranium City and Eldorado, completion of the Key Lake resource access road and a road into the Midwest Lake uranium development.

I have been involved in the road program and particularly the environmental impact process for nearly 5 years. In that time, I have seen many changes in the environmental process, the department's view of the process, and the organizational structure to cope with it. I would like to review some of the difficulties that I have experienced and then comment on two positive factors that were undertaken by our department with respect to the environmental review process.

One of the greatest difficulties that road construction agencies have when an environmental process is first implemented is lead time requirements. Organizations have a built-in momentum that normally progresses from planning, budgeting through to design and construction. Implementation of a new process which requires a considerable increase in project lead time creates stress in the organization. This stress is often manifested in resistance to the new process. I would therefore caution regulatory agencies to consider the lead time and budget implications of new regulations as they are being implemented. They could avoid some of the initial resistance.

Another important factor in implementing an environmental process is the education program that must accompany it. There is nothing more frustrating than being required, or perhaps forced to undertake new studies or to do things in a new way when no one has explained the benefit of the new processes. I am sure that many construction

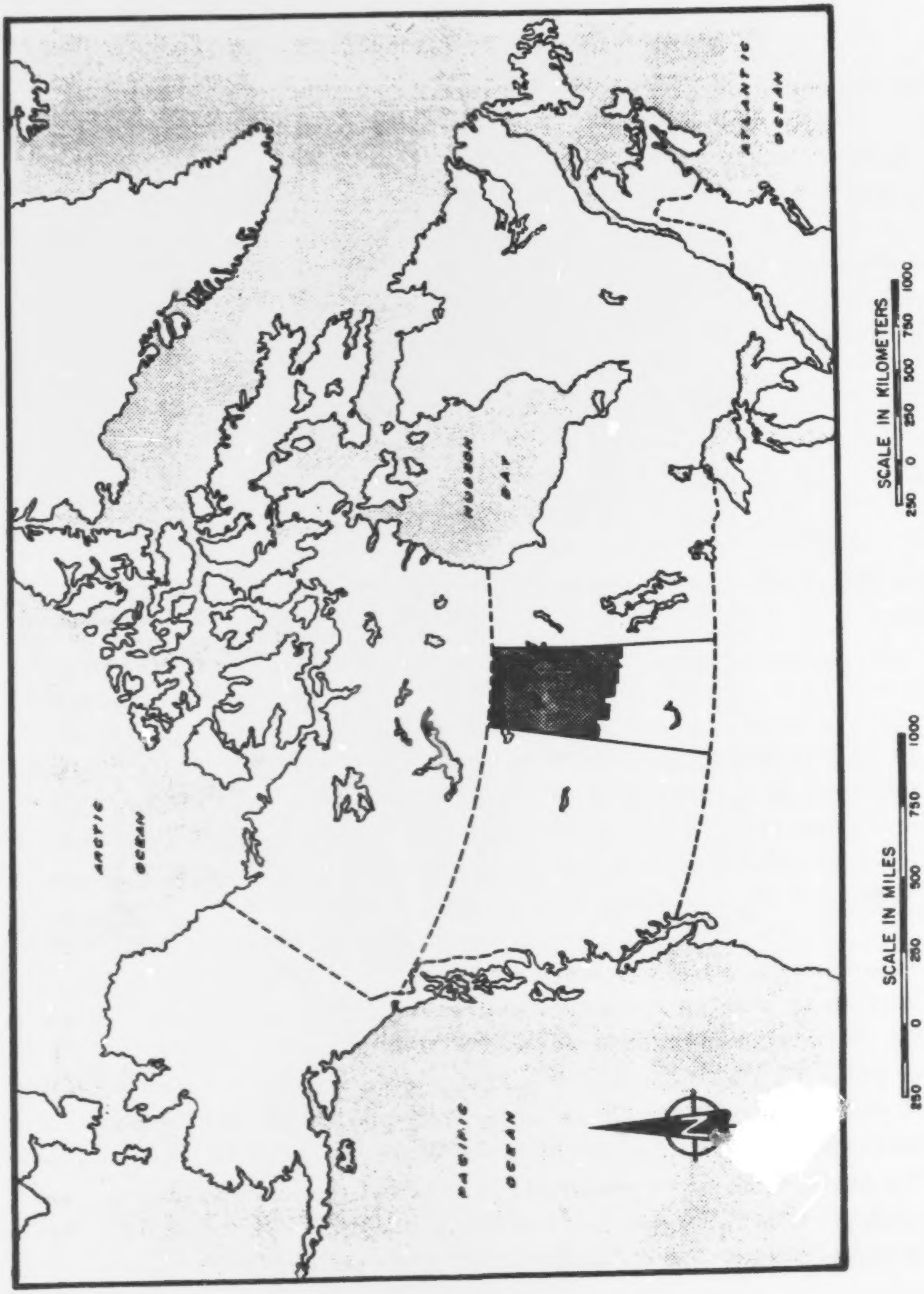

ARCTIC OCEAN
HUDSON BAY
ATLANTIC OCEAN
PACIFIC OCEAN
SCALE IN KILOMETERS
250 0 250 500 750 1000
SCALE IN MILES
250 0 250 500 750 1000
N

PLATE 1

PLATE 2 THE DEPARTMENT OF NORTHERN SASKATCHEWAN HAS BUILT A NUMBER OF COMMUNITY AND RESOURCE ACCESS ROADS, INCLUDING THE STANLEY MISSION ROAD, DESCHAMBAULT LAKE ROAD, PINEHOUSE ROAD, PATUANAK ACCESS ROAD AND THE SOUTHEND CAUSEWAY.

people have seen requirements that have made little immediate sense. Careful implementation can be as valuable as the regulation, especially in the north where terrain restrictions create many unique situations that are not conducive to hard and fast rules. It will certainly be easier to work out suitable compromise solutions if the education process with respect to the regulation has been properly undertaken.

When the Saskatchewan environmental process was implemented, it applied to all projects not yet in the construction phase. This caused a tremendous amount of difficulty for those projects in the late design stages. Because there was no lead time in the system to accommodate environmental impact assessment, the problem became one of getting the project approved as soon as possible so as not to affect the rhythm or momentum that existed in the road delivery program. In these early stages of the process environmental impact issues were not integrated into the design and construction process. The environmental process was treated as a threshold that had to be crossed as quickly as possible. With the exception of time delays, design and construction plans were only minimally changed. The environmental process was perceived to be a superimposition of another function onto design and construction, rather than a part of it. Environmental studies were conducted apart from planning and design activities.

To resolve the problems and conflicts that were developing with this approach, management took some very positive steps to integrate environmental-considerations into the road delivery process. An engineering environmental co-ordinator position was created and incorporated into the design and planning function of the department. With this change all of the roads and transportation activities were incorporated into three separate divisions under the director of the Roads and Transportation Branch. These divisions are:

1) Design, Planning and Environmental Engineering
2) Project Management Co-ordination
3) Road and Airfield Maintenance

As the job title implies, the engineering-environmental co-ordinator co-ordinates the environmental activities associated with our engineering projects. Specific job responsibilities include:

- identify and integrate environmental factors into the project development, pre-engineering and design phases
- initiate, co-ordinate and supervise the preparation of all environmental assessment reports and environmental impact statements and ensure that the project receives the necessary reviews and clearances in accordance with the Saskatchewan Environmental Impact Assessment and Review process.
- monitor the Environmental Mitigation Measures, and
- advise the branch on pertinent environmental rules, regulations, procedures, standards and guidelines and represent the branch at meetings where these items are being discussed.

The integration of the planning, design and environmental functions has been very successful in our department. The close working relations between our design and planning engineers and construction managers and the environmental co-ordinator has helped to raise the consciousness of the road delivery staff with respect to environmental issues. It is very evident in our new locations and designs that the engineers are more readily adopting good environmental practice as part of good engineering practice. This is very important for northern road projects since, in many cases, the single most effective environmental mitigation measure is good route location.

Having an environmentalist on staff has also helped to resolve conflicts in those situations in northern road building where hard and fast environmental rules often cannot be applied. Our environmental co-ordinator has been quite successful in bringing construction related issues to environmental regulating personnel for discussion.

Another positive step incorporated by our branch as a result of the environmental process is the implementation of an environmental education program. The department commissioned the Saskatchewan Research Council to prepare a slide and sound show discussing the environmental issues related to road construction. This presentation was first given to our field staff by SRC. Updating and delivery of this presentation is now handled by our environmental co-ordinator. The presentation includes 119 slides illustrating birds, large mammals, terrain, culvert installation, borrow pits and archaeology.

I would like to review a few of these slides which were prepared for the Key Lake access road (Plate 3).

The presentation on birds discusses the species of birds that are considered endangered or that can be greatly affected by the construction activity. The presentation identifies issues, concerns and good environmental practice as they relate to bird populations (Plates 4-8).

The presentation on large mammals focuses on the major species that occur along the road (Plates 9-11). Information is presented on the problems created by roads and the mitigation measures applied to roads. This diagram (Plates 12-13) shows our practice for clearing. Windrows are to have breaks in them and are to be kept away from the bush so that animals can find the openings. Other problems related to poor and good windrow practice are also discussed.

The presentation on terrain discusses the importance of the vegetative mat and the need to protect it (Plate 14), especially in the vicinity of streams. Plate 15 shows how machinery should use the centre line as much as possible and avoid the edges. Plate 16 shows the difficulty that can occur if the vegetative cover is removed in unstable sand.

Stream crossings and culverts represent the single most visible environmental impact of road construction (Plates 17-19). The presentation concentrates fairly heavily on bad culvert installation as there are many examples from past road experiences. It tries to relate the importance of good culvert installation with slides which the effect of small amounts of silt. The presentation includes designs such as this bridge and culvert (Plates 20-21) to illustrate correct and incorrect practices and the possible effects of

PLATE 3 TO ACHIEVE THE ENVIRONMENTAL PROTECTION MEASURES WHICH ARE NOW PART OF ROAD CONSTRUCTION PRACTICE, A HIGH DECREE OF SKILL AND UNDERSTANDING ON THE PART OF CONSTRUCTION WORKERS IS NECESSARY.

PLATE 4 BALD EAGLES REACH HIGH BREEDING DENSITIES ALONG THE CHURCHILL RIVER AND ARE ALSO FOUND IN THE GENERAL ROUTE FOLLOWED BY THE ROAD.

PLATE 5 HUMAN ACTIVITY AND NOISE MAY CAUSE PARENTS TO ABANDON THE NESTS. THE MOST CRITICAL TIMES ARE APRIL AND MAY WHEN THE EGGS ARE INCUBATING; BUT THE YOUNG ARE STILL IN DANGER UNTIL MID-AUGUST.

PLATE 6 BALD EAGLES AND OSPREYS WILL BE MORE LIKELY TO RETURN NEXT YEAR IF THEY SUCCESSFULLY RAISE THEIR YOUNG THIS YEAR.

PLATE 7 COLONIAL NESTING BIRDS, SUCH AS PELICANS AND GULLS, ARE ALSO IN DANGER IF THEIR NESTING ISLANDS ARE VISITED OR DISTURBED. PELICANS WILL RETURN TO THIS LOCATION YEAR AFTER YEAR. IT IS VERY IMPORTANT TO THEIR SUCCESS.

PLATE 8 GAME BIRDS SUCH AS THIS SPRUCE GROUSE MAY ACTUALLY BE DRAWN TO THE NEWLY CLEARED RIGHT-OF-WAY FOR COURTSHIP ACTIVITIES. HARASSMENT OR ILLEGAL HUNTING DURING THE SPRING AND SUMMER COULD QUICKLY WIPE OUT A LOCAL POPULATION.

PLATE 9 NORTH OF THE CHURCH RIVER THERE ARE VERY FEW MOOSE BECAUSE OF INSUFFICIENT FOOD. MOOSE TEND TO MOVE TOWARDS RIVER VALLEYS IN EARLY SPRING TO TAKE ADVANTAGE OF THE SHRUBS THERE. BEING ALREADY WEAKENED BY A LONG WINTER, THEY ARE PARTICULARLY VULNERABLE TO ILLEGAL HUNTING OR DISTURBANCE BY ANY MEANS.

PLATE 10 WOODLAND CARIBOU ARE PRESENT ALONG THE NORTHERN END OF THE ROUTE, NEAR KEY LAKE.

PLATE 11 THE POPULATION NEAR KEY LAKE IS SMALL AND ISOLATED. A TOTAL OF ELEVEN ANIMALS WERE COUNTED BY AIRCRAFT IN 1978.

PLATE 12 A ROAD CAN EASILY ACT AS A BARRIER TO THE NORMAL MOVEMENT OF BIG GAME. IN THICKLY FORESTED AREAS, WINDROWS OF SLASH CAN ACT AS A BARRIER. THIS DIAGRAM SHOWS OUR PRACTICE FOR CLEARING.

PLATE 13 SLASH PILES ALONG THE KEY LAKE ROAD ARE PLACED WELL OUT FROM STANDING TIMBER AND CONTAIN FREQUENT OPENINGS ALLOWING ANIMALS GREATER FREEDOM OF MOVEMENT.

PLATE 14 ALONG THE ROUTE, THE SOIL IS USUALLY COVERED BY A VERY THIN LAYER OF ORGANIC MATERIAL. THIS COVER OF LIVING AND DEAD PLANTS PROTECTS THE LIGHT, SANDY SOIL BENEATH FROM BLOW-OUTS CAUSED BY THE WIND OR WASHOUTS CAUSED BY SUMMER RAINSTORMS.

PLATE 15 VEHICLES AND MACHINERY SHOULD USE THE CENTRELINE AS MUCH AS POSSIBLE SINCE THE CENTRELINE WILL SOON BE CHANGED ANYWAY. AVOID THE EDGES OF THE RIGHT-OF-WAY, WHENEVER POSSIBLE.

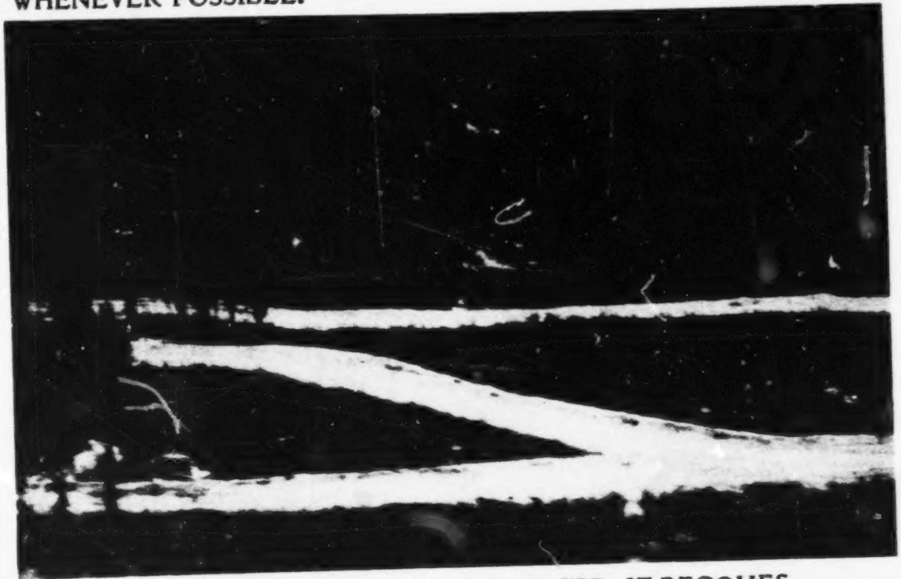


PLATE 16 WHEN THE UNDERLYING SAND IS EXPOSED, IT BECOMES UNSTABLE AND BEGINS TO BLOW AND ERODE AND THE ROAD BECOMES IMPASSABLE. MORE ACCESS ROADS ARE CARVED OUT OF THE HILLSIDE MULTIPLYING THE ORIGINAL DAMAGE THREE TIMES.

PLATE 17 CULVERT INSTALLATION HAS PROBABLY THE GREATEST IMPACT ON FISH RESOURCES OF ANY CONSTRUCTION ACTIVITY.

PLATE 18 EROSION OF FILL OR EROSION OF THE STREAM BANK CAN DESTROY THE DOWNSTREAM FISH SPAWNING AREA. IF FISH ATTEMPT TO SPAWN IN SILTED-IN AREAS, THE INCUBATING EGGS MAY BE DESTROYED BY SUFFOCATION

PLATE 19 THIS EXAMPLE SHOWS THE OUTCOME OF SILT DEPOSIT ON THE DEVELOPING EGGS OF NORTHERN PIKE WHICH IS A RELATIVELY SILT-TOLERANT SPECIES.

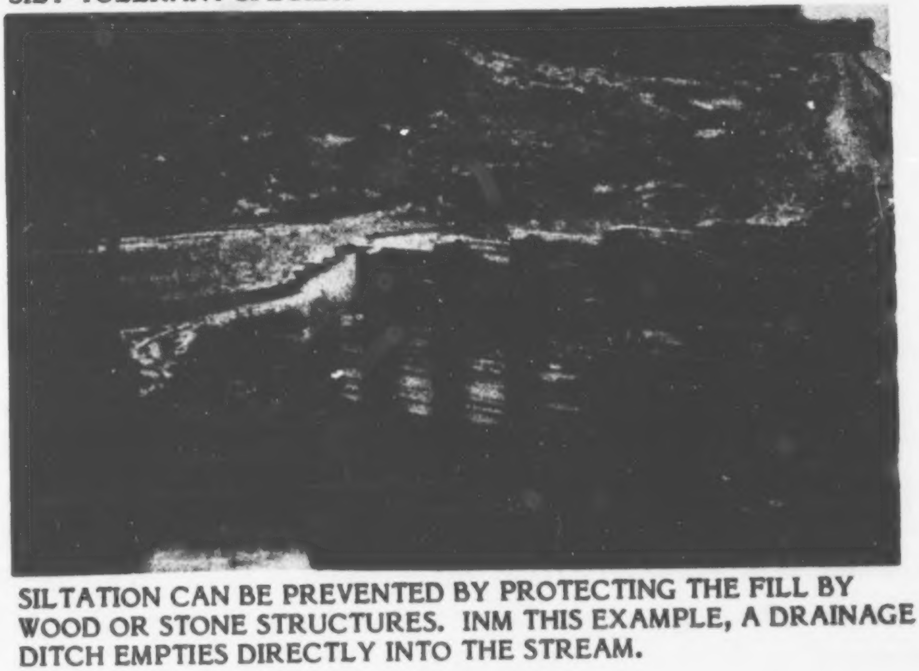


PLATE 20 SILTATION CAN BE PREVENTED BY PROTECTING THE FILL BY WOOD OR STONE STRUCTURES. INM THIS EXAMPLE, A DRAINAGE DITCH EMPTIES DIRECTLY INTO THE STREAM.

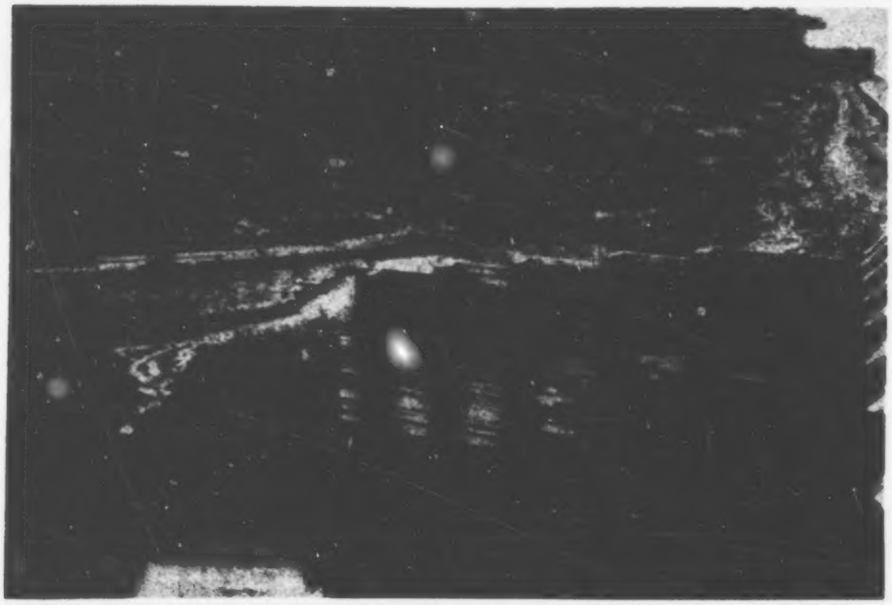


PLATE 21 IF THE DITCH HAD BEEN DIVERTED INTO A LOW LYING AREA NEARBY, THIS AREA WOULD ACT AS A SEDIMENT TRAP ALLOWING SUSPENDED MATERIAL TO SETTLE OUT BEFORE THE WATER EVENTUALLY REACHES THE STREAM.

incorrect installation. In these slides (Plates 22-27) we again see examples of poor construction with a diagram illustrating the proper procedure.

Plates 28-30 show good and bad clearing practice around lakes and rivers and demonstrate the standards to which this work should comply.

This part of the presentation explains the procedures for constructing borrow pits and campsites (Plates 31-32). It provides reasons for leaving buffer strips between these sites and the road and for constructing curved access roads.

The section on archaeology explains some of the history of the route and also explains the types of finds that could occur along the route (Plate 33). It outlines the type of site (Plate 34) that might be spotted by heavy equipment operators and the procedures that field personnel should follow if they locate any archaeological material. The presentation shows examples of items that have been found (Plates 35-37). We are finding that the field employees are showing a lot of interest in the archaeological aspects of the program.

In closing I would like to say that, although our branch has come a long way in accepting and working with the environmental process, we are still having problems with the cost and time factors associated with preparing environmental impact assessments.

PLATE 22 IF THE DISCHARGE IS DIRECTED TOWARDS A POTENTIALLY UNSTABLE RIVERBANK, THE EROSION OF THE BANK WILL CONTINUE TO ADD SILT TO THE STREAM.

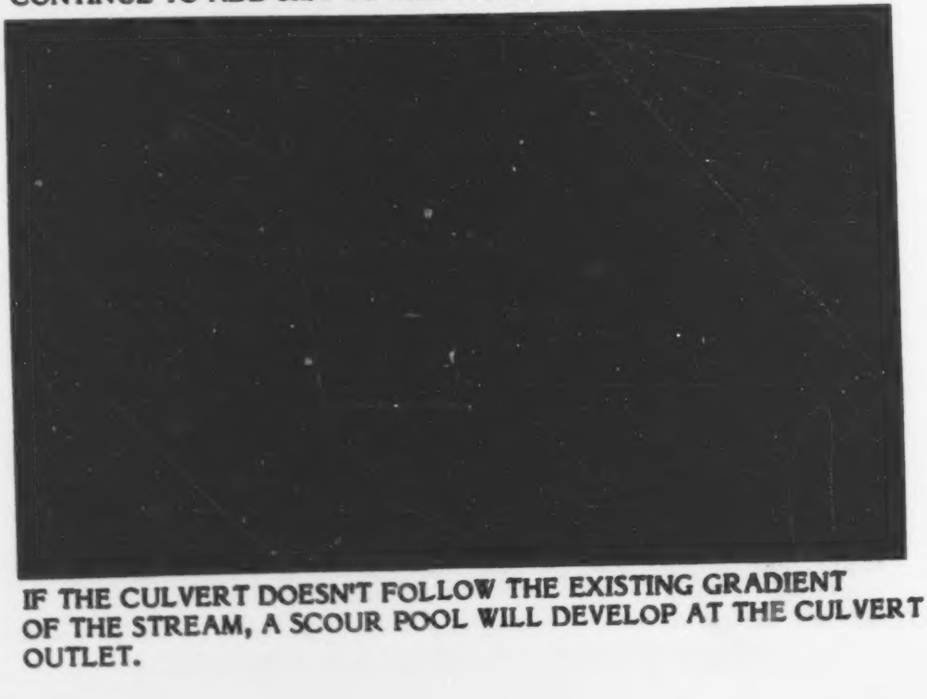


PLATE 23 IF THE CULVERT DOESN'T FOLLOW THE EXISTING GRADIENT OF THE STREAM, A SCOUR POOL WILL DEVELOP AT THE CULVERT OUTLET.

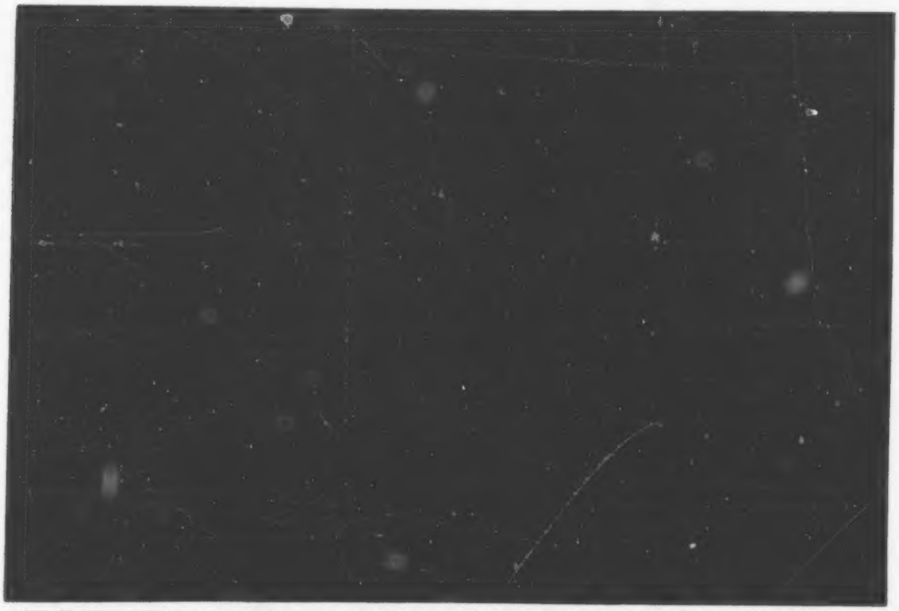


PLATE 24 SILT THAT IS ADDED AT ONE STREAM CROSSING MAY HAVE AN EFFECT FAR BEYOND THAT CROSSING, AS SMALLER STREAMS FLOW INTO A LARGER AND MORE IMPORTANT LAKE OR RIVER.

PLATE 25 ONE POORLY INSTALLED CULVERT CAN AFFECT THE FISH POPULATION OF AN ENTIRE DRAINAGE SYSTEM.

PLATE 26 FISH MOVEMENT CAN BE BLOCKED OR STOPPED AT STREAM CROSSINGS. FISH OFTEN TRAVEL UP SMALLER STREAMS TO SPAWN. THEY MAY MOVE DOWN STREAMS AS THEY GROW OR TO FIND DEEPER AREAS TO SAFELY OVERWINTER.

PLATE 27 THIS DIAGRAM SHOWS THE PROPER METHOD OF INSTALLING A CULVERT.

PLATE 28 THIS IS AN EXAMPLE OF BAD CLEARING PRACTICE. THE RIGHT-OF-WAY SHOULD BE SEPARATED FROM LAKES AND STREAMS. BUFFER STRIPS HELP TO FILTER OUT SEDIMENTS WHICH WOULD OTHERWISE BE WASHED INTO THE LAKE OR STREAM.

PLATE 29 MACHINE CLEARING OF THE RIGHT-OF-WAY SHOULD STOP AT THE OUTER EDGE OF THE LAKE OR STREAM RESERVATION.

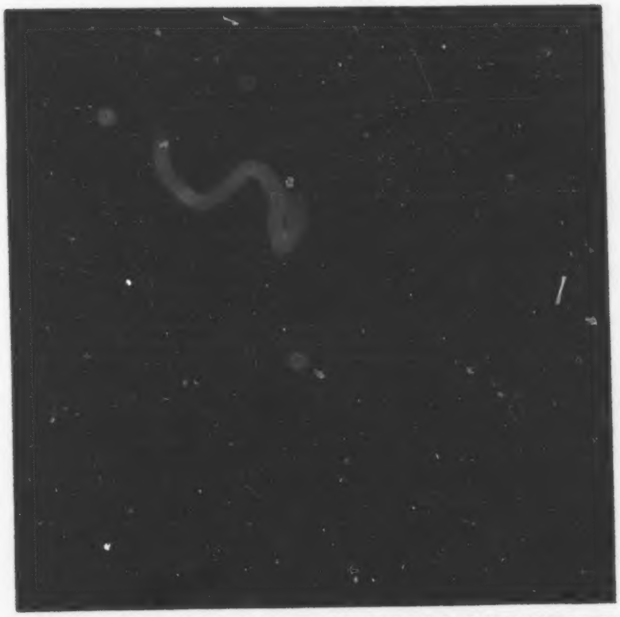


PLATE 30 THE DEPARTMENT OF TOURISM AND RENEWABLE RESOURCES HAS SET OUT GUIDELINES FOR STREAM RESERVATIONS SHOWING HOW WIDE THEY SHOULD BE TO ADEQUATELY PROTECT THE STREAM OR A LAKE EDGE.

PLATE 31 THE KEY LAKE ACCESS ROAD IS A BEAUTIFUL REGION OF SASKATCHEWAN AND THE ROAD CROSSES MANY SCENIC AREAS. THERE ARE CONSTRUCTION PRACTICES WHICH CAN ENHANCE THE VIEW. FOR EXAMPLE, BORROW PITS ARE LOCATED AWAY FROM THE ROAD.

PLATE 32 A SCREEN OF TREES BETWEEN THE CAMPSITE AND THE ROAD WILL ALSO HELP TO BLEND THIS AREA INTO THE FOREST.

PLATE 33 ARCHAEOLOGICAL SITES SUCH AS OLD CAMPSITES, PORTAGES, MARKER CAIRNS, OR CACHES MIGHT BE LOCATED ALONG THE KEY LAKE ROAD. THIS SITE IS LOCATED AT ZIMMER LAKE NEAR THE KEY LAKE URANIUM PROJECT.

PLATE 34
PROBABLY THE ONLY SITE THAT YOU MIGHT DETECT WHILE OPERATING HEAVY EQUIPMENT IS A BURIAL SITE. GRAVES WOULD BE LOCATED IN HIGH GRAVEL OR SAND AREAS, EXACTLY THE PLACES SELECTED FOR BORROW PITS OFF THE ROAD RIGHT-OF WAY.

PLATE 35 THIS ARROWHEAD WAS PHOTOGRAPHED JUST AS IT WAS FOUND, LYING ON THE SURFACE AT A PORTAGE ON THE RAPID RIVER.

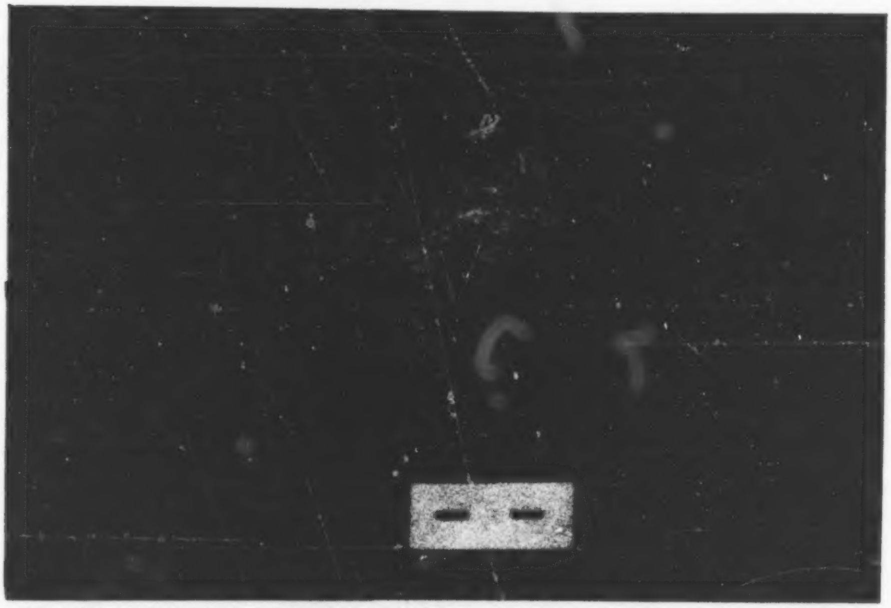


PLATE 36 OTHER ARTICLES WHICH YOU MIGHT FIND ARE OVAL KNIVES, AND GROOVED HAMMERS.

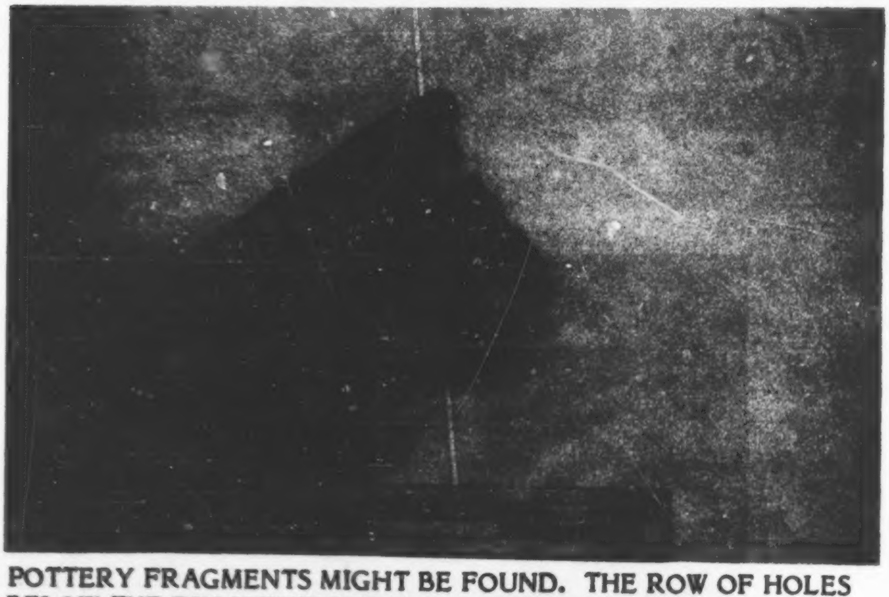


PLATE 37 POTTERY FRAGMENTS MIGHT BE FOUND. THE ROW OF HOLES BELOW THE RIM IDENTIFIES THIS POTTERY AS CREE.

We would encourage periodic review of the environmental processes and regulations to ensure that they are time and cost effective.

Although the northern Saskatchewan terrain has resulted in many situations where hard and fast environmental regulations could not be applied, we were fortunate in having regulatory staff who were willing to discuss problems. As a result of these discussions it was possible to develop solutions that were acceptable to both environmental and construction concerns. This type of regulatory flexibility is extremely valuable in the maintenance of a successful delivery program for resource roads.

The Department has a road transportation policy which requires that all agencies constructing roads, basically mining companies, must contact it to get approval for the alignment. As an extension to that policy, we've got provisions where the Department is willing to undertake the planning for the roads on behalf of the mining company on a cost recovery basis.

The two most recent resource roads are the Key Lake access road and the access road to the Midwest Lake uranium mine. These are both industry sponsored roads with a small percentage of the cost being paid by the provincial government. In the case of the Midwest Lake road, the company came to us and indicated that they wanted a road to their mine site. In accordance with our policy we agreed with that company to do the engineering planning and environmental studies for that road. In the course of doing that project we were able to develop a corridor which not only provided the access required by that company but provided access for 2 other companies as well. The cost was shared by all companies.

Our Department is also interested in having northern residents participate in the construction process.

Discussion

CS By participation do you mean employment on the construction operation or do the public have an input in the planning stages?

AH Our process allows for some public input into the planning process. For example, when we develop an access road, we set up liaison people in the Northern communities. The liaison person is responsible for supplying our Department's information to the community and vice versa. Once the environmental impact assessment is prepared we have the normal process of public review, which in our case is about 6 weeks.

CS Do you have somebody on staff that is a liaison person?

AH Normally our environmental work is done by consultants. In setting up our most recent consulting contracts, we've made some allowances for liaison people in the northern communities to find out where the resource users are and to try and assess the impact of the project on them. We've tried other methods to get at the resource users but they haven't been quite as successful.

JM On one slide you had a class 1 stream, class 2 stream and a fish bearing stream with different widths for buffer strips. Could you explain those classifications?

AH They're classifications with respect to the size of the stream and the number of tributaries flowing into the stream and were given to us by our fisheries people. Any stream that has a fisheries potential is automatically rated as class 2 and requires a 100 ft. buffer rather than a 50 ft. buffer. Our Department also has a set of guidelines that address road construction at stream crossings. The guidelines are fairly specific in terms of what we should be doing in relation to different types of water bodies.

PS You mentioned cost sharing. Does that include the cost of construction? Do your people do the construction work?

AH When a company wants us to do the planning for the road it's total cost recovery. Once the company is ready to build a corridor the provincial government provides some subsidies if there is a provincial interest in the road. In the most recent case costs are being shared 85% by 3 mining companies and 15% by the government and that includes construction.

RB Can you describe your environmental screening process?

AH Once we've identified a project there's a requirement to write up the project. Guidelines for submission of projects by proponents are available. Once a project has been identified, it is written up according to the guideline and submitted to the Department of the Environment for an initial review. The review is conducted by about 7 or 8 government departments with a turn around time of about 4-6 weeks. If there is sufficient information and if the project is fairly minor in nature the project will be approved. However if the project is deemed to have significant environmental impact the proponent is directed to conduct an environmental impact assessment. We generally require data for 4 seasons in our EIS. Once completed, the EIS is reviewed by a screening committee. If the EIS is satisfactory the project will be approved. However if the impacts uncovered by the EIS are of such a nature that it requires a higher degree of public participation, a board of inquiry would be struck for the project. Some projects are rejected at the board of enquiry stage although not many.

RB What about drafting guidelines to do the EIS, who would do that?

AH The Department of the Environment provides general guidelines or terms of reference to be used by consultants. It's still up to the proponent to ensure that he's got all of the areas covered.

STH Does this apply to all kinds of roads?

AH Yes.

STH How long does the process take?

AH We allow ourselves a year and a half to two years from the day application is made. This is dependent upon the impact, the length of the road and how long it takes to prepare the EIS. Sometimes four seasons data is not necessary. In that case a document may be prepared in 3 months. Certainly the length of the process encourages good planning. Winter roads are an exception. A lot of winter roads are single season roads - one or two cat blades will go thru without any type of environmental assessment. On the other hand I've been involved in road projects that have taken a year and a half.

PS You must have patient operators.

AH Unless the project receives environmental approval an operator will be unable to clear the land. If he does, he's fined by the number of trees he knocks over. That's our control mechanism.

STH Compare that to the 10 day review period in the Yukon.

AH Certainly the 10 days does not seem to allow for a proper review. In our process we have a lot of public consultation so that by the time we get to the public review period we are not dealing with too many problems that we're not aware of and these can be resolved a lot more quickly.

GM Once a company has permission to put in a winter road, what constraints are used to make sure that the people who put it in know what they are doing?

AH When a company receives approval either with or without an environmental impact assessment, the approval is always conditional to certain restrictions. For example, when the Department of Environment gives the go ahead to build the road there are certain restrictions included in the terms such as stream crossings, clearing and brush disposal. Also, the Resources Branches of our Department handling the permits provides additional restrictions with respect to clearing and slash.

PS Who determines whether there is going to be an impact?

AH It's done by an internal screening committee of the Department of the Environment consisting of representatives from a number of departments. Archeology is represented by the Department of Culture and Youth, Tourism, Forestry and Fisheries by the Department of Tourism and Renewable Resources, agricultural land by the Department of Agriculture, certain northern interests are represented by members of our department.

PS Is the private sector represented?

AH No, it's a government review panel. Getting back to the issue of time (to do proper assessments) - We've had several years to stretch our planning, design, and construction activity to accommodate the environment process. When (the process) was first dropped on us we had a big problem and we didn't really deal with some environmental issues. But now we've accepted it and we've moved the environmental process right into the design and planning process. That's really been the major change. And you can see the improvement in environmental design; we're putting in bridges now where we might have used culverts; we're putting in three stand bridges where we might have used two etc. We're also moving our design along a lot faster.

BM Are the costs of environmental impact studies charged to the developer?

AH If it's a road project that is being constructed for a developer, yes. We construct a fair number of community access roads and in that case the costs are paid by the government.

PF You mentioned having the environmental co-ordinator in the design group. Does that mean that instead of having design done by the engineers alone, you now have an environmental coordinator in the design group.

AH In the beginning there was a disassociation between engineering and environment so we brought the fellow in and he is part of the team; he is responsible for preparing the EIS which goes to the Department of the Environment. When we're initiating a project i.e. when we're into the planning stage, he prepares the initial document to go to the Department of the Environment for initial screening. He gives the information directly to the design engineer or the planning engineer and we incorporate it immediately.

CS Are the guidelines for the production of the environmental impact assessments for the construction and operation of the road?

AH The guidelines that I was referring to are for the preparation of the impact statement. The Department of Environment has drafted guidelines for construction but they are not ready for external review yet. These guidelines will reduce the need for a lot of environmental impact statements. Projects would go thru the screening process and be approved subject to agreement with the guidelines.

The problem we had when consultants prepared the EIS, was that they worked out of their office and we worked out of our office and if the consultant identified a problem, we didn't know about it until we had the

EIS. By that time we were pretty committed to our design in terms of bridges, purchasing of materials etc. The other problem was in getting information to the consultant. The coordinator/environmentalist we have on staff now has a better feel for the information the consultant will need, so having him in our department to get the information to the consultant and to get feedback from him is really appreciated. I should add that we have no capability to do in-house assessments.

RB You mentioned earlier that the selection of the proper route is probably one of the best ways to minimize environmental impact. How do you put that into your EIS guidelines.

AH When we identify a need to go from one point to another there are two ways of going about it. One is to prepare an environmental sensitivity chart of the area to get agreement on areas to stay away from. However, we really don't have enough of that kind of information to prepare sensitivity maps for the entire area in which we're working. We use air photos. We look at the starting point for the road and the destination and usually find that there are so many terrain restrictions between the two we're left with only a few corridors to choose from. Then we start the environmental process on a manageable amount of territory. The environmental assessment perhaps deals with 2-5 kilometres on either side of the line that we choose. We get additional engineering information as well.

We are involved in a study for a winter road to Stony Rapids and the question of how we arrived at our alternatives is a very touchy one. The road is 160 kilometres in length and from our air photo studies we've only come up with two fairly viable alternatives and there's some concern about the rationale used in the selection of these alternatives. Although there are no plans for an all weather road for perhaps 10 years in this area we're doing the EIA on the basis that perhaps an all weather road may be constructed in the future. Thus we're ensuring that the selection of the corridor for the winter road is also suitable for an all weather road.

RB How are your heavy equipment operators reacting to the briefing program?

AH We work at the operator level because they do have some control in terms of driving equipment into the water, pushing a new trail to a lake to go fishing etc. Those kinds of things are under their control and certainly providing this kind of information is helpful. However we also need to educate at the supervisory level.

EROSION PROBLEMS ENCOUNTERED IN NORTHERN ROAD CONSTRUCTION

by

Perry Savoie

Of all the environmental concerns addressed by DIAND's Land Use Section over the years, erosion problems have predominated. An initial analysis would lead one to conclude that erosion in the Yukon is not as serious as in other areas of the country where annual precipitation is greater. Low precipitation rates in the Yukon can lull one into the feeling that the erosion potential is low. Normally this would be the case, but several factors combine to greatly increase the Yukon's potential for erosion. Glacial till soils with a high content of silt fines are well distributed in the Yukon. These soil types are easily eroded by water. The fact that Yukon soils are not a good growth medium is well documented. This gives rise to areas which are sparse in vegetation which does not facilitate the stabilization of erodible soils.

The growing season in the Yukon is short. This factor combined with poor soil fertility and depth and low precipitation inhibits the rate of vegetation growth.

The purpose of this workshop is to examine northern road construction and its attendant environmental problems. This paper reviews various methods of erosion control that can accompany road construction. Most methods are commonly used in other parts of the country, as well as in the north with reasonable success.

To refresh our memories, the three types of water erosion are: sheet, rill and gully. In the north, a unique phenomenon also occurs, subsidence resulting from ice melt-out in areas where soils have a high ice content.

Sheet Erosion - Soil is being removed in small uniform amounts over the disturbed area. Usually the gradients are moderate and there is moderate to excessive rainfall.

Rill Erosion - is more severe than sheet erosion, not necessarily because of a larger quantity of suspended sediment, but because the damage is confined to small individual rivulets that become deeper over a period of time (Plate 1).
Large quantities of soil can be eroded during a storm.

Gully Erosion - is an advanced stage of rill erosion (Plate 2). Gully erosion results in many cases from denuding an area so that a concentrated run-off occurs. If the concentration of water is high, gully erosion can result almost immediately.

PLATE 1 RILL EROSION-ON OLD DRILL (EXPLORATION OIL & GAS) WELLSITE.

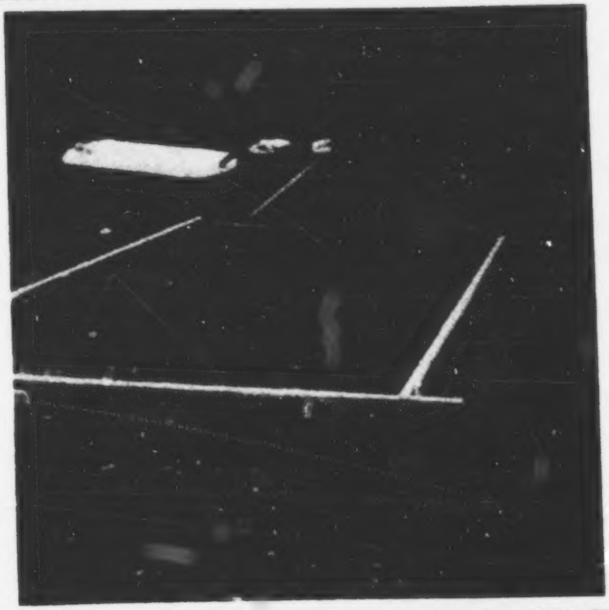


PLATE 2 SAME AS PLATE NO. 1 EXCEPT FOREGROUND SHOWS MUCH MORE SERIOUS EROSION THAN BACKGROUND AREA. RILL EROSION PROBABLY CRITICAL STAGE AND HAS NOW BECOME GULLY EROSION.

Subsidence - In many areas in the southern to mid-Yukon discontinuous permafrost is encountered (Plates 3-4). The Northern Yukon is predominated by continuous permafrost. Where ice rich soils are exposed to direct heat, melt out of the ice causes depressions which in turn become water collectors. If the terrain is sloped, severe gully erosion can result.

Two highly erodible soie regimes occur most frequently. They are:

(i) The high potential run-off group. Soils have slow infiltration rates when thoroughly wetted, layers that impede the downward movement of water and a moderately fine to fine texture. In the Yukon we find such soils in many areas. They consist of silts and silt sands, usually deposited by streams (Plate 5). In some areas, early aeolian deposits also occur. Old lake beds also are of similar material.

(ii) The very high potential run-off group are soils having very slow infiltration rates when thoroughly wetted. They consist chiefly of clay soils with a high swelling potential, a permanent high water table, and a clay pan or clay layer at or near the surface. They overlay a nearly impervious or impervious material. Many permafrost areas fall into this category. The frozen layer is impervious and associated with clay silts. Many lakes have a layer of sand over impervious clay. Another area of heavy soil clay is in the Southwest corner of the Yukon. These two soil groups tend to promote a lateral rather than vertical water movement. In many areas of the Yukon, especially on slopes, this creates a slumping and sliding of materials, even on well vegetated sites. This was noted in the "Mac Pass" area last year.

With regard to road construction where erosion tends to accompany surface disturbance, the main factors influencing the rate of erosion are: the area of exposed soils on slopes, slope angle, slope length, the size or type of ditches constructed, the actual slope of the road grades and the type and amount of material used and the size of fill areas.

There are various methods of control that can be initiated; some are better than others, but all will retard or minimize erosion, thus allowing vegetation to become established and eventually protect the slope.

Control methods include:

1. Terracing. This must be done in a correct manner if it is to be successful. Poor cuts can create a concentration of water in the soil which can lead to

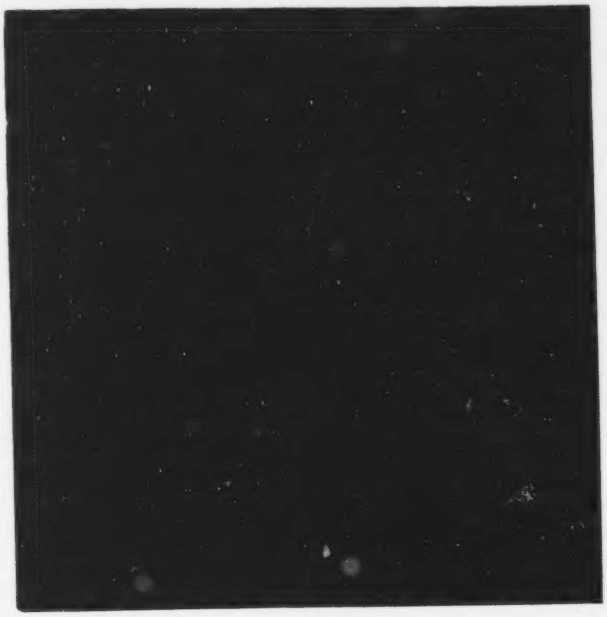


PLATE 3 MINIMAL SUBSIDENCE FROM MELT OUT ON OLD FIREGUARD.

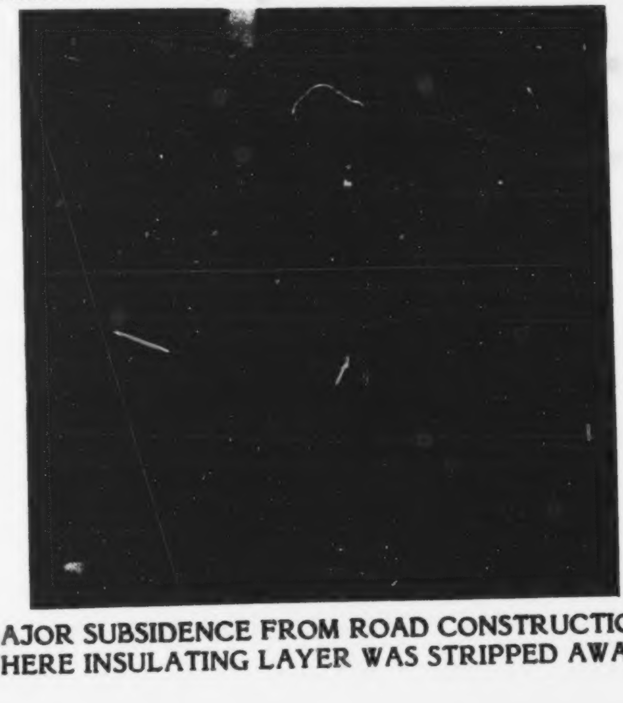


PLATE 4 MAJOR SUBSIDENCE FROM ROAD CONSTRUCTION PROGRAM WHERE INSULATING LAYER WAS STRIPPED AWAY.

PLATE 5 DEPICTING TYPE OF LIGHT SOILS FAIRLY COMMON IN YUKON.

slumping. The benefits are quicker revegetation and slope stability. The disadvantage may be the additional exposure of mineral soil. Terracing is being conducted on some of the major highways at this time but to date there has been no follow-up to measure the success.

2. Placement of brush, debris and trees. Again the correct method of placement must be used in order to achieve maximum effectiveness. The brush creates micro-sites that speed up revegetation and stabilize soils. The disadvantage is that it is not pleasing, aesthetically. This method has not been used much in the Yukon but should be considered.

3. Placement of mulch material. Mulch was used on the Alaska Highway and also on the Shakwak Project. It was successful but the method is costly. It looks better aesthetically. This method should be considered for highly erodible slopes but must be used with a tackifier or it won't work.

4. Scarification has been used in some areas, again on the Alaska Highway. There are some reservations with this practise as the exposed surface soil is usually loosened up. This is advantageous from the viewpoint of establishing

vegetation, but if the soil is not conducive to immediate growth, the loose soil may be carried away by sheet erosion.

5. In areas where sub-surface ground water is present a catch basin or trench or flume catch system connected to slope drains will prevent erosion. This system has worked in other areas especially during construction phases. It has never been tried in our area but should be seriously considered.

The next area of concern is ditch stabilization and protection. This can be accomplished by using:

1. Ditch blocks - constructed of rip-rap and overburden, brush or debris, trees, logs or rocks. Straw bales are used in southern areas; Sediment traps should be used along with the ditch blocks.
2. Interceptor off-shoot ditches should be constructed at intervals and in areas where the run-off is diverted into heavily vegetated areas. This will help settle out sediment and also prevents further erosion. Drainage may be required to divert flow across the road at intervals.
3. Revegetation by seeding should be considered in all cases. In some cases a mulch and matting may be required along with seeding.

Another area of concern is road surface and shoulder erosion. It can be minimized by using:

1. Cross ditching methods. The purpose is to intercept and divert surface run-off to lines of natural drainage. An aid to cross-ditching is to slope the road surface to the downhill side. No berm should be left on the downhill side unless a slope drain is utilized. Cross ditches must be constructed in a manner that will allow all vehicles to pass over them without destroying the ditch. Culverts should be considered in areas of heavy vehicular use.
2. Shoulder erosion can be minimized by placing brush and debris stripped from the surface on the downhill side or the top of the ditch slope. Rocks will impede erosion.

All these methods will assist in stabilization of the soils and in doing so create favourable sites for better revegetation. Again, soil types will determine the timing of artificial revegetation (Plate 6). In most cases in the north, except on some of our highways, we tend to allow natural vegetation to re-establish.

PLATE 6 NATURAL REVEGETATION BEGINNING TO RE-ESTABLISH.

Other factors that can reduce problems are route selection; keep in mind the terrain and natural vegetation in the area (Plate 7); streams in the area; slope aspect (are you on a north or south aspect?); permafrost areas (Plate 8).

We could go on forever on road construction practices as there are a number of papers and reports done on the subject outlining various techniques and practices. There is one thing we must keep in mind, however, northern roads have been built in the past, many with success and they will continue to be built for some time to come. If a number of proven practices are utilized, the erosion problems encountered in the Yukon can be minimized. New methods not yet tried should possibly be considered in the future.

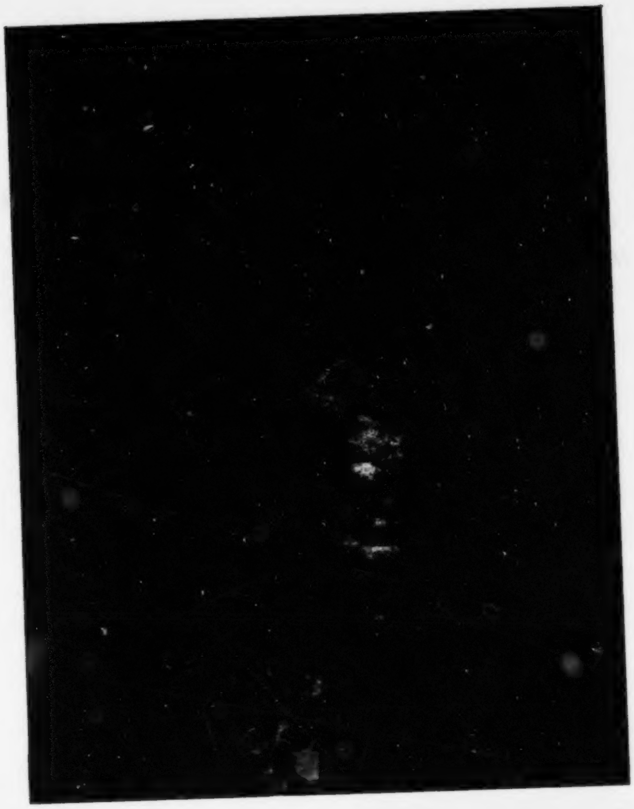


PLATE 7
ROUTE FOLLOWED SHOWS MORE LEVEL TERRAIN, BARRIER VEGETATION HELPS IN THIS CASE TO ASSIST IN RE-ESTABLISHMENT OF VEGETATIVE COVER.

PLATE 8

ROAD CONSTRUCTION IN PERMAFROST AREAS - SHOWS MINIMAL DISTURBANCE TO INSULATING COVER AND OVERBURDEN. END DUMP METHOD OF CONSTRUCTION WAS CONDUCTED ON THIS ROAD.

REFERENCES

1. Federal Highway Administration "Best Highway Management Practises for Erosion and Sediment Control." December 1978.

2. "Environmental Design for Northern Road Developments." Report EPS-8-EC-76-3. Environmental Conservation Directorate. October 1976.

3. "The Resource Handbook". Alberta Forest Service. ENR. Report No. 75.

4. "A Revegetation Guide for Alaska". Alaska Rural Development Council. Publication No. 2. May 1977.

5. Brown, R.J.E. Permafrost Investigations in British Columbia and Yukon Territory. Technical Paper No. 253. National Research Council of Canada. Division of Building Research. December 1967.

6. Information Manual. "Approaches to Erosion Control." Habitat Protection Unit. Fisheries Services. March 1974.

DISCUSSION

PS This slide shows how unstable some of our soils are. Rainfall is light and as you can see, rill erosion has almost become gully erosion, probably over just one season. Here is a good example of subsidence in permafrost. You end up with gully erosion and pretty soon a water channel has been created.

JK Are they likely to revegetate?

PS Eventually they stabilize but the scar will always be there. I've run across examples north of Beaver Creek; one area of subsidence has been there for about 25 years and it doesn't look much different from this one, which was created around 1972. This is another slide of subsidence, once you get water you get increased melt out. Only at a certain stage does it stabilize as frost builds up again. Gradually vegetation will establish itself.

This slide shows an old seismic line. You can see that the natural revegetation is quite good.

As you can see in this slide, we have total brush disposal. We don't do it in all areas though - only where it's likely to be in the public eye.

JK How do you bring these techniques to bear on tote trails when your people are usually not there when the operator is building his road?

PS There are communications with the applicant when the permit is issued on erosion control methods. We have a number of control methods in place now and they are communicated on a person to person basis from the resource management officer (who is the land use inspector), to the permittee or the operator in the field. A lot of the techniques we use were developed on a trial and error basis in the field.

MD Perry, it's nice to see that your department now appreciates the value of leaving brush when constructing roads. A few years ago we had a sub committee look at the possibility of not requiring the disposal of brush by burning. From the wildlife standpoint, it's a great idea.

PS I haven't sold the department on it yet. But the technique works very well for slope stabilization etc.

MD I was working in an area west of Edmonton a number of years ago and when they cleared the right of ways the brush was never burned. It was left in piles and these piles became tremendous habitat for snowshoe hares and of course the predators.

RB What we've got here is environmental design with a double payoff - erosion control and improved wildlife habitat.

CS In Colstrip, Montana they had problems when they reseeded new areas and heavily fertilized them in the mined land reclamation program. The tremendous growth of grass and vegetation in these areas attracted rodents with unfortunate results. So they moved in brush piles and rock piles (1 or 2 every 10 acres or so) and established some snags in the area just by sticking them in the ground. This attracted raptors, foxes, weasles etc. and helped to control the rodent population - at a cost of perhaps a thousand dollars for the whole block.

AH I was interested to hear that windrows are of some benefit. Generally what we like to do is windrow, let it sit a year or so then walk a cat across the top to squeeze it down. We've been asked in some cases to spread the brush into the ditches which, from an aesthetic point of view, may not be desirable.

PS I should qualify what I said about brush disposal. We only go to total brush disposal on major highways and secondary roads. On trails we have total disposal on sections which are likely to be seen by the public. But on small access trails or on winter roads we do not have total disposal.

AH One of the problems that we've had is that our resource and tourism people feel that any all weather access road is a public road (from tourist point of view) and therefore they're looking for 100% disposal.

HIGHWAY ROUTE LOCATION IN THE NORTH

by

George McCormick

I will concentrate on the problems of highway location and have a number of slides which will help to illustrate the points I wish to make. The first thing the location engineer has to do is collect all available information in the area in which he will be working. Topographic maps must be obtained. Usually, when you get this far north the largest scale available is about 1:250,000 or 4 miles to the inch. There are parts of the territories with the 1:50,000 scale but normally up here you're working with the smaller scales.

This is a physiographic map of Canada (Plate 1). An engineer locating the road should have a good knowledge of physiography. Along the Mackenzie valley near the river you find a lot of fine grained soil particularly silts and clays which not only have a high ice content but are generally poor embankment material. Also, in cuts they are susceptible to erosion and permafrost degradation. On the other hand, when you locate a little distance away from the River, you find soil that is much better for road construction. The ice content is much lower. So a location engineer has to keep in mind the type of soil he will encounter and he should of course know which ones are best.

Here we see a technician laying out an uncontrolled mosaic of aerial photographs (Plate 2). By the time you get to this stage your route is starting to get narrowed down to a fairly narrow band maybe several kilometres wide or sometimes narrower. Some of the other information which we use are maps showing wildlife habitat, migration routes, waterfowl nesting areas etc. Other maps which are available, particularly in Northern Alberta and Saskatchewan are forest cover maps at a scale of about 1 inch to a mile or 1:50,000. They were originally produced for logging companies and the forestry service but the civil engineer has found that they contain a lot of useful information. The type of tree gives a clue as to the type of soil and the topography.

PLATE 1 PHYSIOGRAPHIC MAP OF CANADA.

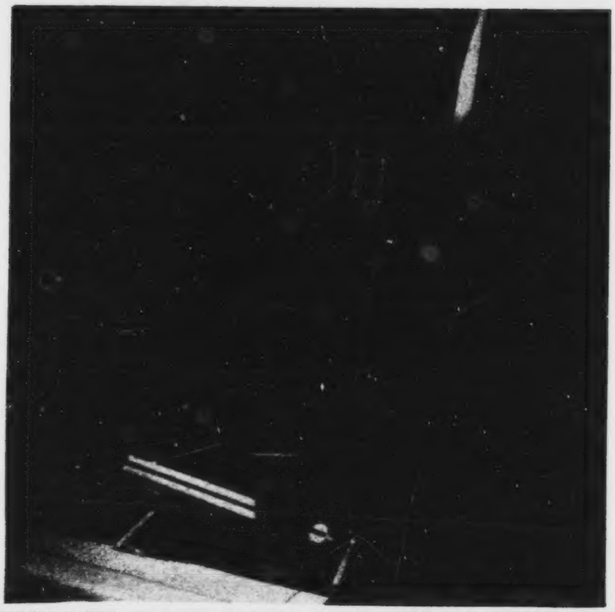


PLATE 2 AN UNCONTROLLED MOSIAC OF AERIAL PHOTOGRAPHS IS LAID OUT AND BY THIS STAGE THE ROUTE IS NARROWED DOWN TO A BAND SEVERAL KILOMETERS WIDE.

After the location engineer has sketched out his route on his mosaic, picked out potential areas for borrow material and noted potential problem areas he should fly the route, preferably in a helicopter. He should also get out occasionally and walk the route. By this time, the route should be pretty well defined, although alternative routes may be required in certain places.

This slide shows a permafrost polygon north of Inuvik (Plate 3). Their size and shape will give you a clue as to the type of soil. The smaller, more regular polygons are generally found in finer soil with high ice content (Plate 4).

This slide shows a palsa (Plate 5) which is a gigantic frost boil with peat on top. This one is in the Norman Wells area and we went thru about 8 or 9 feet of clear ice. Obviously, you don't want to put a highway cut thru that.

This slide (Plate 6) was taken in the Imperial Range just north of Norman Wells. At the foot of this range, you'll see a lot of talus (Plate 7). At first sight this looks like good material for borrow but unfortunately, a lot of that talus has very high ice content. If it were coarse, let's say broken limestone, it wouldn't be so bad but a lot of that material is too fine grained. Plate 8 shows a fine grained alluvial fan that might look like a good source of borrow but you'd probably be disappointed if you start digging into it.

This is a picture of the Mackenzie Highway just a few miles south of the Inuvik Airport (Plate 9). Thru the centre of the photograph is the highway embankment. This was taken after there'd been problems during construction. When DPW began work here they tried to get borrow in the conventional manner from borrow pits but a lot of the soils in this area have a high ice content. It was obviously not suitable so they opened up rock quarries and used the local shale and dolomite.

This slide was taken in Northern Alberta (Plate 10) and you can see there's a meandering stream with oxbows. Obviously in this area you've got fine grained soils with a high moisture content and hence it is not

PLATE 3 EXAMPLE OF A PERMAFROST POLYGON NORTH OF INUVIK.

PLATE 4 SMALLER, MORE REGULAR POLYGONS ARE GENERALLY FOUND IN FINER SOIL WITH HIGH ICE CONTENT.

PLATE 5 EXAMPLE OF A PALSA WHICH IS A GIGANTIC FROST BOIL WITH PEAT ON TOP. THIS ONE IS IN THE NORMAN WELLS AREA.

PLATE 6 PHOTOGRAPH TAKEN IN THE IMPERIAL RANGE JUST NORTH OF NORMAN WELLS.

PLATE 7 AT THE FOOT OF THE IMPERIAL RANGE THE TALUS HAS A VERY HIGH ICE CONTENT AND IS TOO FINE GRAINED MAKING IT UNSUITABLE MATERIAL FOR BORROW.

PLATE 8 THIS ALLUVIAL FAN IS A FINE GRAINED MATERIAL WHICH IS POOR MATERIAL FOR BORROW.

PLATE 9 THE MACKENZIE HIGHWAY ABOUT 3 MILES SOUTH OF INUVIK AIRPORT.

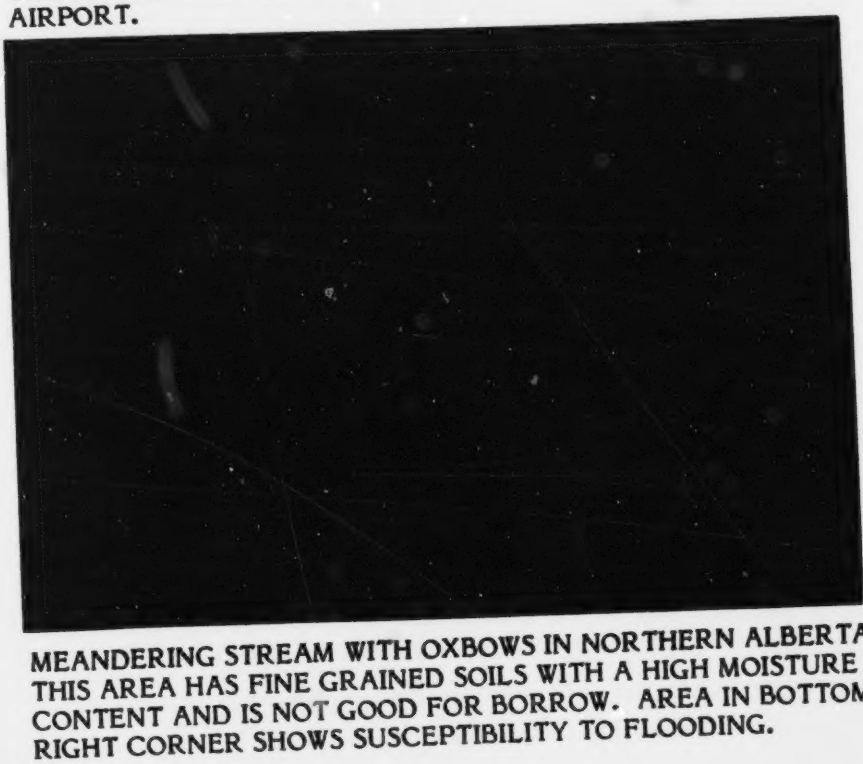


PLATE 10 MEANDERING STREAM WITH OXBOWS IN NORTHERN ALBERTA. THIS AREA HAS FINE GRAINED SOILS WITH A HIGH MOISTURE CONTENT AND IS NOT GOOD FOR BORROW. AREA IN BOTTOM RIGHT CORNER SHOWS SUSCEPTIBILITY TO FLOODING.

good for borrow. Also, rivers such as this are susceptible to flooding, as you can see in the bottom right hand corner.

This picture was taken in the Mackenzie Valley area (Plate 11) and as you can see, there's a lot of water and muskeg. There's permafrost thru most of the area and borrow material is in short supply. I think you can see stands of aspen poplar there. They usually indicate the best locations for borrow material. This is getting pretty close to the northern limit of aspen poplar and just a few miles south of here is the most northerly location of Jack Pine. Jack Pine is a good indication of material suitable for borrow. The species likes fine grained sandy soils and it won't grow where the permafrost table is close to the surface.

This is a slide of the Dempster Highway in the Yukon, about mile 50 (Plate 12). As you can see, the terrain is very different from the Mackenzie Valley. Here, route selection is quite a lot easier because you're confined to the valleys. In some ways your route is pretty well picked for you. Of course you have to watch for the gradient and other details.

Pipeline location is easier because you don't have to worry about gradients. Mainly what you worry about is slope erosion. River crossings are pretty easy.

Highways are not always easy to locate and in this location (Plate 13) in the Mackenzie Valley we ended up with a highway going around behind that rock 2 or 3 miles in the left hand background. With a railway, the only way you could get around that obstacle would be to tunnel thru the rock. This photograph was taken in a test trench (Plate 14). It shows the massive ice and obviously, if you build anything over that and the ice melts, you've got a big problem.

This slide shows samples of soil (Plate 15) from the test site at Sans Sault. When we split the samples open you can see quite a lot of ice which, once it thaws, hasn't got any shear strength. It's literally just like soup because of the high moisture content. To build a highway embankment over that, you've just got to assume that, in the next few

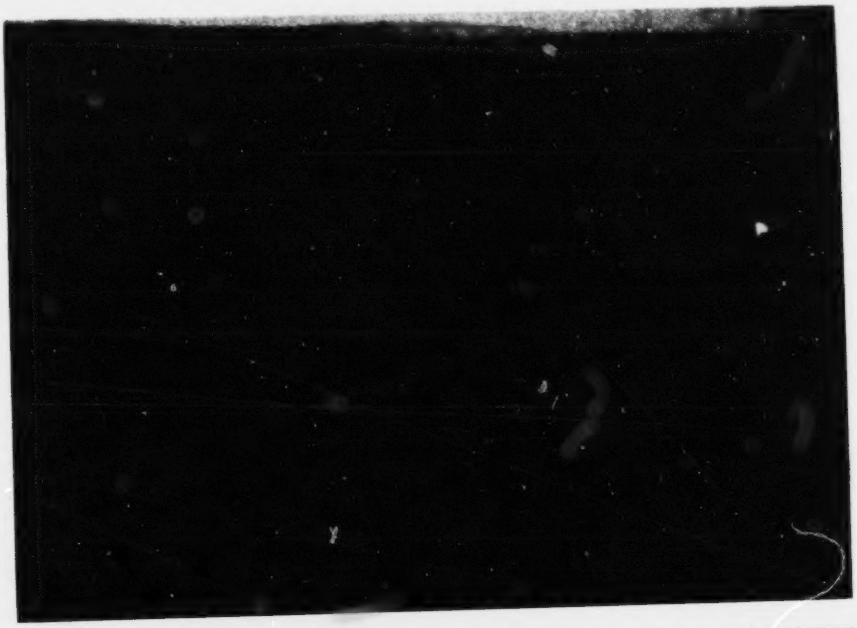


PLATE 11 IN THE MACKENZIE VALLEY AREA THERE IS A LOT OF WATER, MUSKEG, PRACTICALLY CONTINUOUS PERMA FROST, AND BORROW MATERIAL IS IN SHORT SUPPLY.

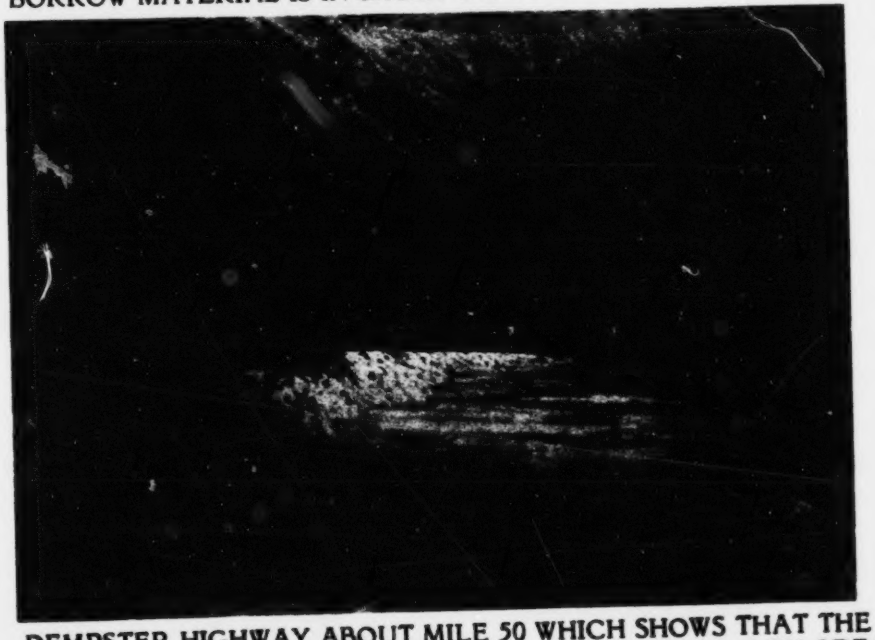


PLATE 12 DEMPSTER HIGHWAY ABOUT MILE 50 WHICH SHOWS THAT THE TERRAIN IS VERY DIFFERENT FROM MACKENZIE VALLEY AREA. ROUTE SELECTION IS EASIER BECAUSE IT IS CONFINED TO THE VALLEYS.

PLATE 13 HIGHWAYS ARE NOT ALWAYS EASY TO LOCATE AND IN THIS LOCATION IN THE MACKENZIE VALLEY, WE ENDED UP WITH THE HIGHWAY GOING AROUND BEHIND THAT ROCK 2 OR 3 MILES IN THE LEFT HAND BACKGROUND.

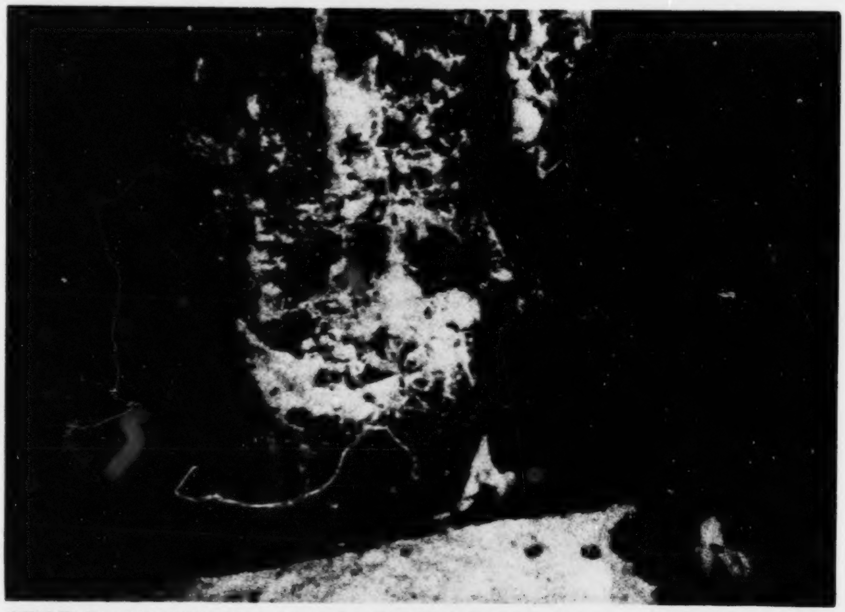


PLATE 14 TEST TRENCH DUG AT SANS SAULT SHOWS MASSIVE ICE. THE MEASURING STICK IS MARKED OFF IN FEET.

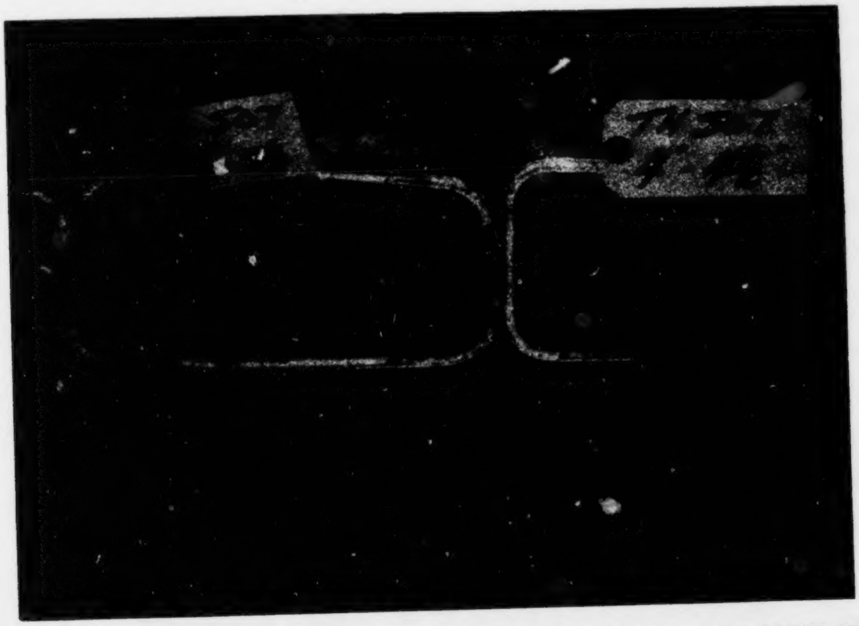


PLATE 15 SOIL SAMPLES FROM TEST SITE AT SANS SAULT. BECAUSE OF THE HIGH ICE CONTENT AND BEING FINE GRAINED, THE SOILS HAVE NO SHEAR STRENGTH. IF ALLOWED TO THAW UNDER A HIGHWAY EMBANKMENT OR UNDER A BUILDING, IT BECOMES LIKE SOUP AND SETTLEMENT OCCURS.

years following construction, you're going to get a certain amount of settlement and you'll just have to keep dressing up your embankment. You might get a foot of settlement in this soil say over 5 or 10 years, after which the rate of settlement would then taper off. Up around Inuvik we found that if you put an embankment of clay about 4 feet high over this material it wouldn't thaw. With gravel or broken rock in Inuvik you need about a 7 foot high embankment. Once you get as far south as Norman Wells, there's no way your going to stop permafrost from thawing if you build a highway over it. It's going to thaw and there will be no end to the problems.

This is a picture of a drill rig which we used in the north quite frequently (Plate 16). This is in the area south of Fort Simpson where we went in and drilled 6 years ago while doing a research project for the Mackenzie Valley Gas Pipeline. This slide shows the helicopter taking off with the drill rig (Plate 17). That drill rig weighed about 3300 pounds.

PLATE 16 THIS IS THE TYPE OF DRILL RIG WE USED IN THE NORTH QUITE FREQUENTLY.

PLATE 17 SAME AS ABOVE. THE DRILL RIG WEIGHED ABOUT 3300 POUNDS.

This picture was taken on the Dempster Highway between Arctic Red River and Fort McPherson (Plate 18). The road was built out of shale and formed a pretty good embankment. One problem is that this shale is very weak; a lot like the shales we get thru Northern Alberta and BC. Once you put it in an embankment and expose it to the weather, the shale reverts to clay and becomes just like grease. Then you have to cap it with broken rock or gravel.

This is a picture of the road between Inuvik Airport and Inuvik town (Plate 19). It was built in the early 1950's. We drilled thru the embankment to asertain the effect of this road on permafrost. We found that the permafrost table was about 4 feet below the top of the embankment so essentially, the permafrost table was higher under the embankment then under the original ground surface.

This is a picture of a seismic line in the Norman Wells area (Plate 20). We drilled to find out how deep the permafrost had degraded beneath it. We found that once a seismic line is cleared like this, with the moss and peat stripped off, and you take a profile across it, you find the permafrost is down 18 inches in the bush but in the middle of the seismic line it might be down 15 to 20 feet.

This slide shows a creek running into the Mackenzie River (Plate 21). You can see that there's a lot of gravel in the river and crossing it with a road or a pipeline would lead to problems with fish spawning and difficulties during high water in spring. In these rivers a tremendous amount of water comes down in the spring, for maybe a week or two, and you have to design for it.

This slide was taken between Arctic Red River and Fort McPherson (Plate 22). You can see the different types of terrain. Thru the middle there's a great slash which is muskeg with a very high water and ice content. On either side is spruce on stable ground but with soils that are not very good for building an embankment.

This is a picture of a tube sample from the Mackenzie Valley (Plate 23). As you can see, we obtained clear ice with just a bit of soil in it.

PLATE 18 DEMPSTER HIGHWAY BETWEEN ARCTIC RED RIVER AND FORT MCPHERSON. THIS STRETCH WAS BUILT OUT OF CRETACEOUS SHALE.

PLATE 19 THE ROAD BETWEEEN INUVIK AIRPORT AND INUVIK TOWN. THE PERMAFROST TABLE WAS FOUND TO BE ABOUT 4 FEET BELOW THE TOP OF THE EMBANKMENT THEREFORE IT WAS HIGHER UNDER THE EMBANKMENT THEN UNDER THE ORIGINAL GROUND SURFACE.

PLATE 20 A SEISMIC LINE IN THE NORMAN WELLS AREA. PERMAFROST IS DOWN 15 to 20 FFET WHERE THE LINE HAS BEEN CUT BUT ONLY 18 INCHES IN THE BUSH.

PLATE 21 A CREEK RUNNING INTO THE MACKENZIE RIVER. SEE TEXT FOR DESCRIPTION.

PLATE 22 AREA BETWEEN ARCTIC RED RIVER AND FORT MCPHERSON EXEMPLIFYING THE DIFFERENT TYPES OF TERRAIN (SEE TEXT).

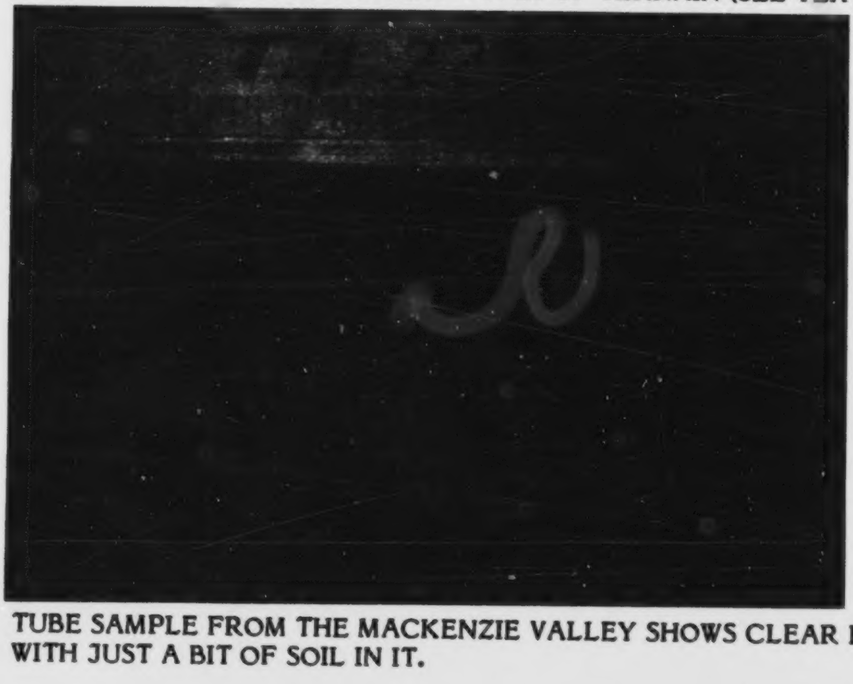


PLATE 23 TUBE SAMPLE FROM THE MACKENZIE VALLEY SHOWS CLEAR ICE WITH JUST A BIT OF SOIL IN IT.

Obviously if this melts and if it were located under a road you would have potential problems.

This drill rig was used in the Mackenzie Valley and this is our "circus tent" (Plate 24). We set up over the hole, put down the sides, turned up a propane heater inside and worked thru the winter. We didn't miss a single day of work even when the temperature was down to about -55 degrees Fahrenheit.

This is a picture of a Texoma drill rig (Plate 25). It is the type of rig that's used in Inuvik for drilling piles. In this case we were drilling along the Mackenzie highway to obtain soil samples. It's a very fast rig for that type of work.

This is a Mayhew drilling rig (Plate 26) used on the Mackenzie Highway. We got excellent core samples with this rig. Behind it we've got a shack that we towed along. It was insulated and heated and we were able to drill with this set up just about every day thru the winter.

This is one of our mobile labs (Plate 27). It's about 9 1/2 feet square. We have two technicians working in here and you would be amazed at the amount of work they can turn out in one day.

This is a camp moving along the Mackenzie Highway location line (Plate 28). Right behind the first cat we've got an electric generator and behind that we've got the unit that contain the office, the lab and the washrooms. Behind that again is the cook shack and a couple of bunk houses. We had about 21 men in that camp.

This is in the Mackenzie Valley and shows the kind of erosion you can cause when people get careless with cats and other equipment (Plate 29). This photograph was taken in October 1970. The snow hides quite a lot of sins but even so you can see the amount of erosion that took place. What happens with these higher ice content soils is that as the permafrost melts you get degradation and the ground just settles. Because the soil is very weak (it has no shear strength) you get run off when it rains or when the snow melts. Of course the soil erodes very easily and very often ends up in the nearest water course.

PLATE 24 THIS IS THE DRILL RIG THAT WAS USED IN THE MACKENZIE VALLEY AND OUR "CIRCUS TENT". BY SETTING THE TENT UP OVER THE HOLE WE WERE ABLE TO WORK IN ALL WEATHER CONDITIONS.

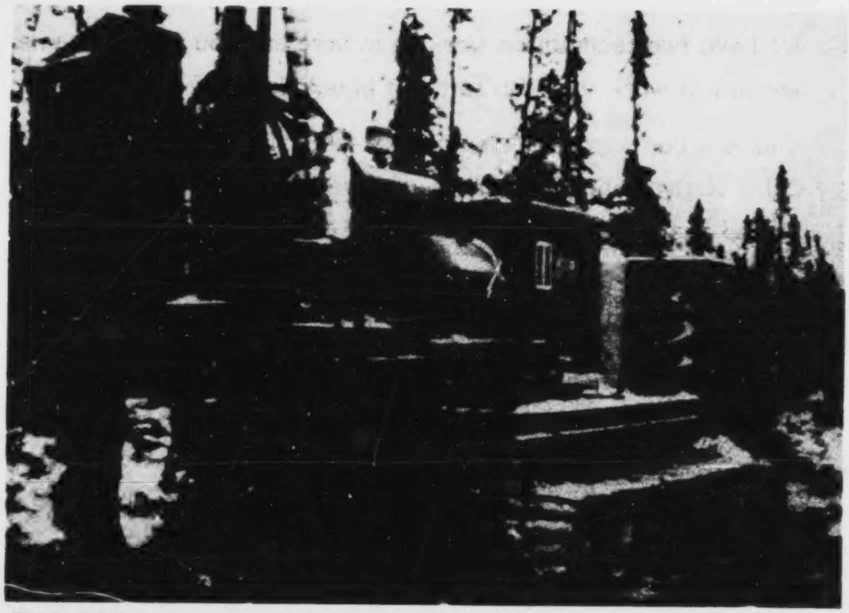


PLATE 25 THE TEXOMA DRILL RIG WE USED ALONG THE MACKENZIE HIGHWAY TO OBTAIN SOIL SAMPLES.

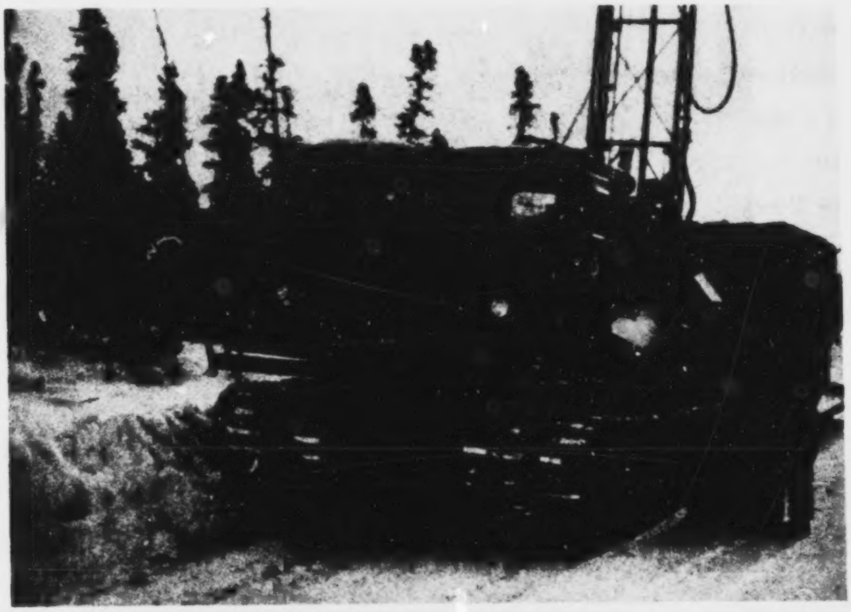


PLATE 26 A MAYHEW DRILLING RIG USED ON THE MACKENZIE HIGHWAY FOR CORE SAMPLES.

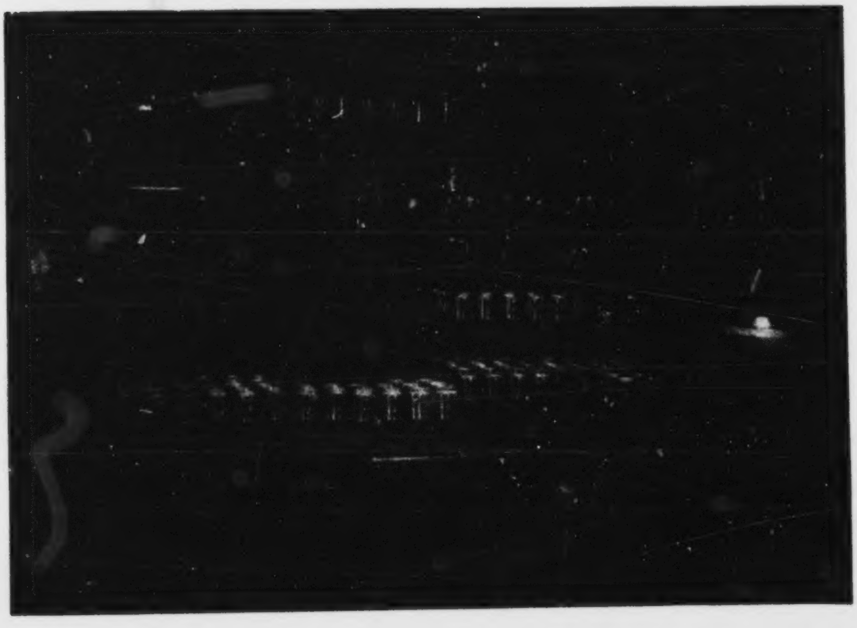


PLATE 27 THIS IS ONE OF OUR MOBILE LABS. IT'S ABOUT 9.5 FEET SQUARE.

PLATE 28 THIS IS A CAMP MOVING ALONG THE MACKENZIE HIGHWAY LOCATION LINE. SEE TEXT FOR DESCRIPTION.

PLATE 29 THIS IS IN THE MACKENZIE VALLEY AND IT SHOWS THE KIND OF EROSION WHICH CAN BE CAUSED WHEN PEOPLE GET CARELESS WITH CATS AND OTHER EQUIPMENT.

This is another photograph taken in an oil field north of Fort St. John (Plate 30). It's just getting to the southern tip of permafrost. We didn't find any permafrost at this site. The oil company made a pad to drill a well by digging with a cat into the hill side. They then pushed the dirt to make a level pad and worked on that. After the well was producing the pad started to slide towards the nearest river.

PLATE 30 PHOTOGRAPH TAKEN IN AN OIL FIELD NORTH OF FORT ST. JOHN.

I find the most serious problems with northern highway location construction are the shortage of good material for the embankment and also gravel. A large source of gravel in the north is in rivers. At one time we simply went down to the river with a drag line and took it out but because of potential impacts on fisheries that is not done now. Another source of gravel in the north are eskers. Unfortunately, they never seem to be where you want them. I've come across a few eskers in the Mackenzie Valley but not too many in the Yukon. Eskers are a good source of gravel material because the material is sorted naturally.

Somebody asked me yesterday how much extra it costs to build a road on permafrost compared with non-permafrost areas. It's been my experience that in the north, of course it's a lot more expensive to build a road than in the south. But I think most of the extra expense is due to logistics, location of site, etc. Other than that I don't think building a highway on permafrost is necessarily that much more expensive that on non-permafrost areas.

Discussion

JM What alternatives have you found to taking gravel from streams, or do you still take gravel from streams? If so what sort of techniques have you employed to minimize fisheries concerns?

GM I haven't seen anyone take gravel from a stream for about 20 years. I understand you can obtain permission under certain circumstances eg. if you can show that it's not a spawning ground and if you limit your activities to certain seasons. The alternative, of course, is to head back down the road to the nearest source of gravel. On the Dempster Highway, there is a hundred mile long stretch with not one source of gravel.

Hauling costs are close to 50 cents a cubic yard per mile, so if you've got to haul the gravel 60 miles that's 30 dollars a yard which is awfully expensive.

HM We've been involved for 3 years in extending the Tuktoyaktuk airstrip. When you talk about 50 and 60 mile gravel hauls, let me tell you in the past 2 years we've been moving about 40,000 total yards off the MOT pit in Inuvik and barging it to Tuck. It costs us 40 dollars a yard to move it.

We stockpiled approximately 50 thousand yards and the next spring when we started spreading it we were left with 30,000 yards. The 50,000 yards thawed so by the time we spread it on the airstrip we only had half the gravel we started with.

GM In a conventional borrow pit, in areas of permanent frost, a yard of soil for the embankment yields half a yard when it thaws. Whereas when a cubic yard of solid rock is blasted and crushed, one and one half cubic yards are produced. That's why the economics of using rock are a lot better than you might think at first. In addition, a rock quarry is not as unsightly as a borrow pit in certain areas.

PF Richard Fyfe has recommended that when these rock quarries are closed that just a small amount of extra blasting will provide ledges for falcons to nest, if you're in an area where falcons exist.

YELLOWKNIFE WORKSHOP PROCEEDINGS

MARCH 19, 20, 1981

ENVIRONMENTAL PROBLEMS AT STREAM CROSSINGS

by

Robert Baker

This paper is an account of work I did in the Yukon and to a lesser extent in the Northwest Territories during 1977-79. The purpose of the work was to identify environmental problems associated with northern roads and to develop recommendations. Most of the results have been published in an EPS report entitled: "Environmental Concerns and Recommendations: Alaska Highway reconstruction and maintenance". Additional results will be discussed for the Howards Pass Access Road and the Liard Highway.

To begin, I'll go through 31 slides which identify some of the issues that I feel ought to be dealt with. It is my belief that these issues apply to northern roads in general. The slides will be discussed under 5 subject headings, beginning with culvert installation.

Culvert Installation. This slide (Plate 1) shows a minor stream crossing - a snow melt run-off channel on the Howards Pass Access Road. According to a report done by Lorne Cooper there is a problem with these minor stream crossings. They cause terrain disturbance problems and some of the channels may cause secondary impacts to fisheries resources in other watercourses eg. the Little Nahanni River.

Some of the culverts are undersized (Plate 2) and there's a severe icing problem in the spring. Because the culverts are blocked, the stream creates another channel across the road (Plate 3). Lorne's recommendation is to get rid of the culverts and use fords instead. One of the recommendations from the Yukon is to use 2 culverts, one on top of the other. John Hudson from DPW, Whitehorse discussed this design at the Whitehorse workshop and thought it was very effective and a relatively inexpensive way to get at the severe icing problems that they periodically encounter on some of the stream crossings in the Yukon.

This slide (Plate 4) shows a minor stream crossing in the Yukon with massive disturbance. Part of the problem in the Yukon, too, is that they use road graders for road maintenance. It is facetiously referred to as

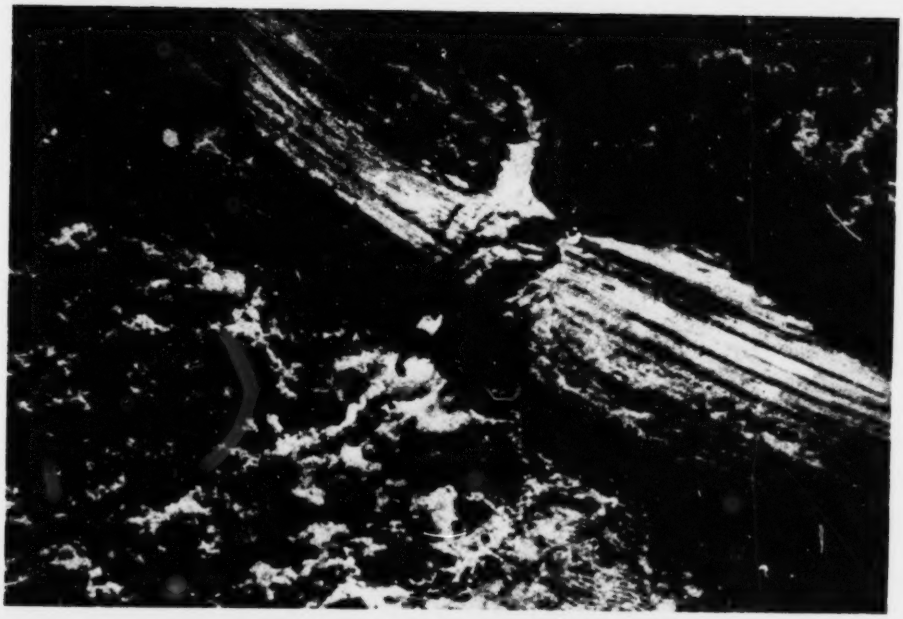


PLATE 1 CULVERT WASHOUT, HOWARDS PASS ROAD

PLATE 2 LOCATION AS FOR PLATE 1

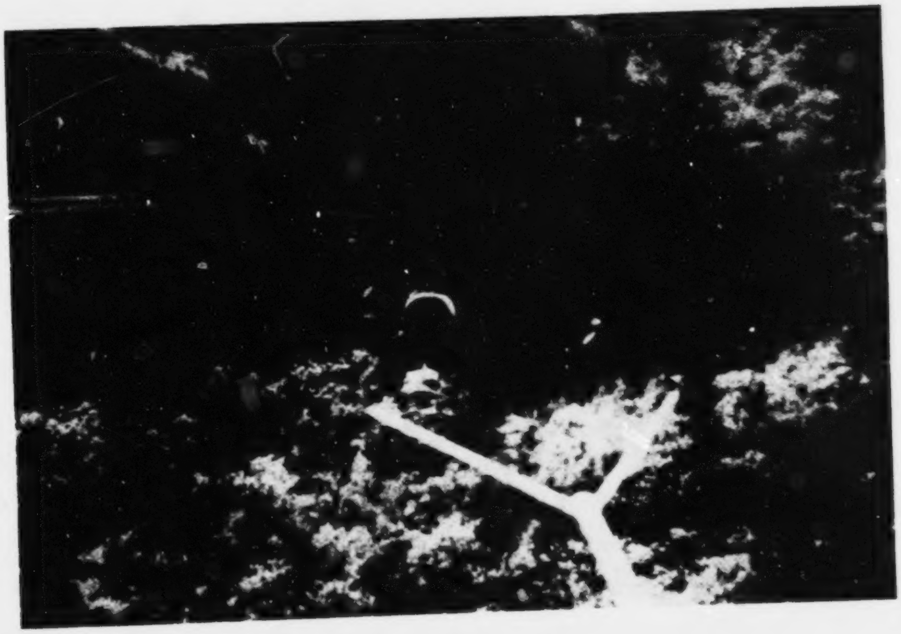


PLATE 3 LOCATION AS FOR PLATE 1

PLATE 4 MINOR STREAM CROSSING SHOWING EXTENSIVE TERRAIN DISTURBANCE CAUSED BY ROAD GRADERS.

the YTG "scorched earth" policy and they recognize that it doesn't have a lot of merit. Minor streams are, by definition, not fisheries streams but there are definite concerns for maintaining good open drainage for flood control and wetland maintenance and for protecting the fisheries streams which these streams may flow into.

This culvert installation (Plate 5) is not aligned properly. The problem of alignment was noted at the Whitehorse workshop along with the problem of raised culverts. It was concluded that culverts should be on the natural stream gradient and that inverts should be below the stream bottom.

Saskatchewan requires that inverts be placed 6 inches below the stream bottom. That is certainly not the case throughout the Yukon although on recent work on the Shakwak they are doing an excellent job. Culverts are also well installed on the Liard Highway.

From an engineering and fisheries protection standpoint this slide shows how not to install culverts (Plate 6). These additional slides further illustrate the point (Plates 7-10). They are fairly representative of what you will find on just about any road in the Yukon. They are installed horizontally rather than on the stream gradient and you can see the problem this causes at the culvert inlet and outlet. The stream drops down (Plates 11-13) as it moves from the stream gradient to the horizontal culvert gradient at the entrance and from the horizontal culvert gradient to the stream gradient at the exit.

A few culverts in the Yukon are properly installed and this slide shows one of them (Plate 14). The inverts are below the stream gradient and stream bottom material has moved naturally into and through the culvert. From a fisheries standpoint this is exactly what you want since it's a good simulation of the nature stream environment. It's also good from an engineering standpoint.

Ditches. This ditch (Plates 15-16) on the Liard Highway shows silt problems. It represents a serious problem in the Yukon as well. What you really need, I believe, are temporary erosion control plans to handle this kind of problem, particularly during summer storms. These pictures were taken on the Liard Highway. A lot of the material shown in the

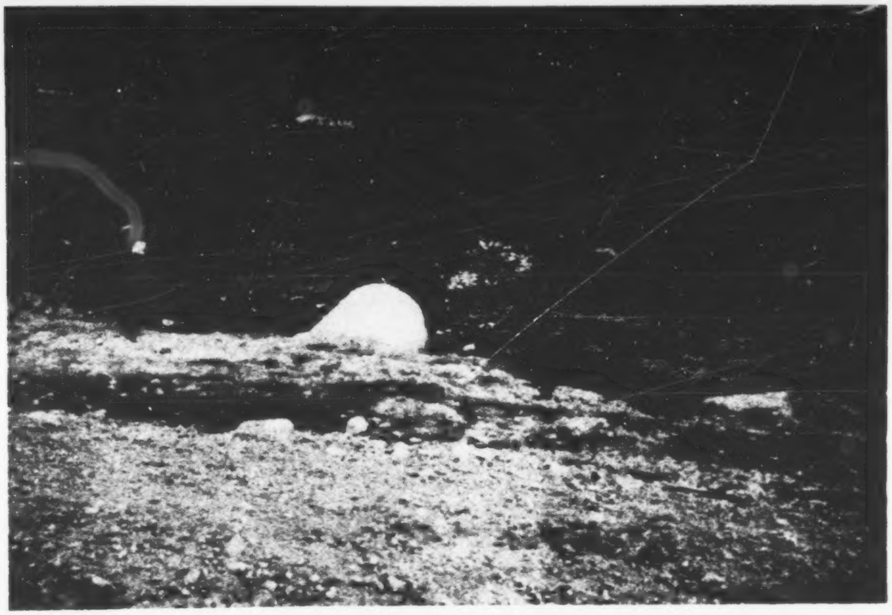


PLATE 5 MINOR STREAM CROSSING EXTENSIVE TERRAIN DISTURBANCES ALIGNMENT PROBLEM, RAISED EXIT.

PLATE 6
RAISED CULVERT EXIT,
ALASKA HIGHWAY.

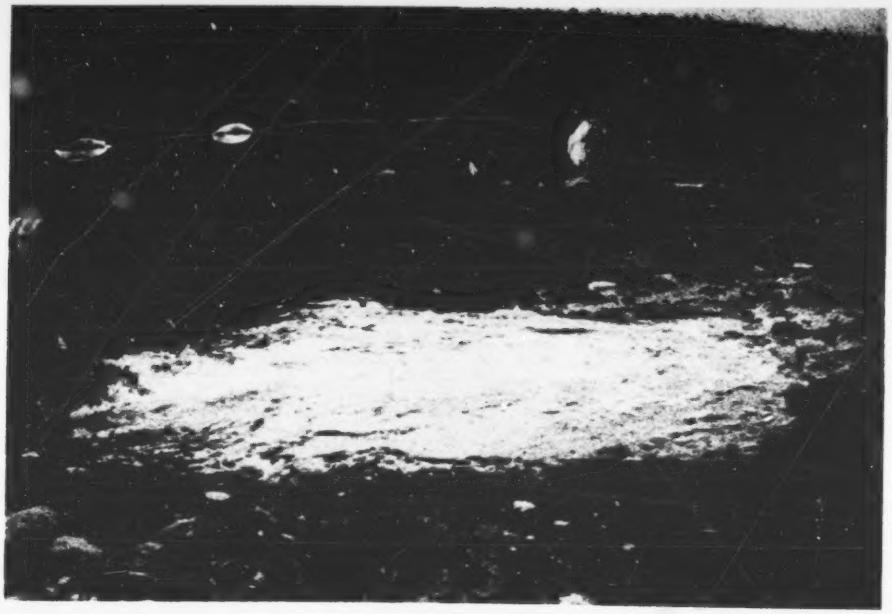


PLATE 7 RAISED CULVERT EXIT.

PLATE 8 RAISED CULVERT EXIT.

PLATE 9 RAISED CULVERT EXIT, EXCESSIVELY STEEP, HIGHLY ERODIBLE FORESLOPE.

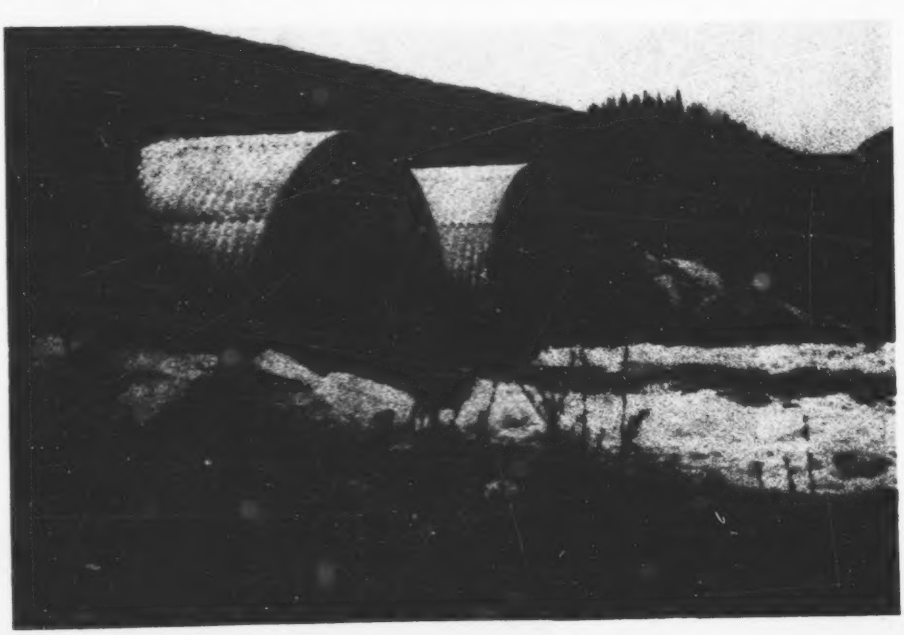


PLATE 10 RAISED CULVERT EXIT.

PLATE 11 DEPRESSED CULVERT ENTRANCE.

PLATE 12 DEPRESSED CULVERT ENTRANCE.

PLATE 13 DEPRESSED CULVERT ENTRANCE.

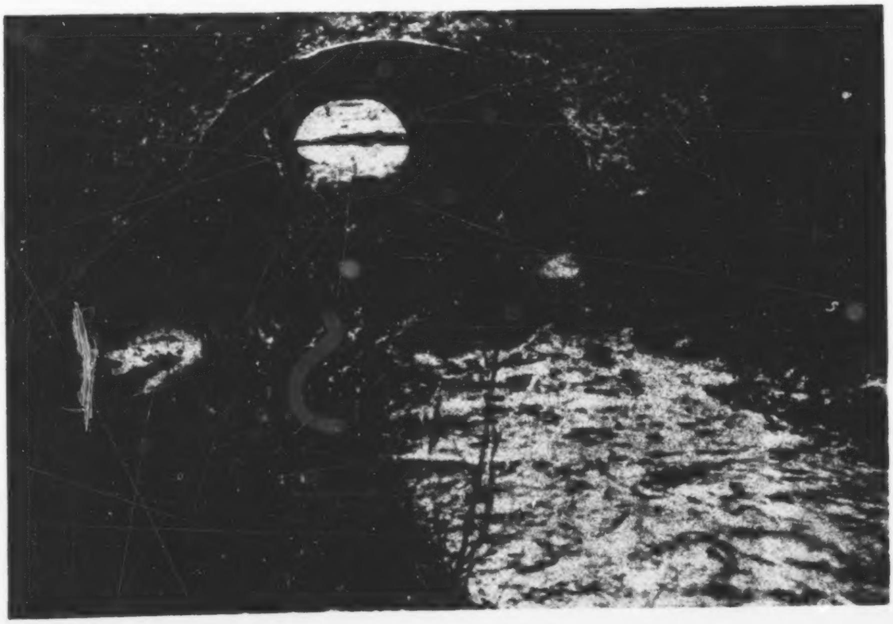


PLATE 14 CULVERT INSTALLED ON STREAM GRADIENT, INVERTS BELOW STREAM BOTTOM.

PLATE 15 DITCH EROSION AND SILTATION, LIARD HIGHWAY.

PLATE 16 DITCH EROSION, LIARD HIGHWAY.

slides can get into nearby streams and interfere with local drainage and fisheries. They illustrate the type of maintenance problem you run into if you do not institute erosion control measures; temporary ones when construction is underway and permanent ones after construction is completed (Plate 17).

This slide shows a small stream near the Yukon River. A good summer storm and most of this silty-sandy material will find it's way into the nearby stream (Plate 18).

This slide (Plate 19) shows the kind of problem you encounter when silt does get into the stream. Brush barriers can be used to control the problem. A bit of brush was inadvertently left at the side of the road and you can see in the slide that it can be effective. Since there are many areas in the Yukon and NWT where rip-rap for erosion control is extremely scarce brush could be used to help control run-off. In the Yukon they do not remove brush on resource roads except where it is visible to the public, i.e. aesthetic concerns are really felt to be important in the Yukon. I don't know what policy exists in the NWT, but I do feel that aesthetics has to take a 2nd or 3rd seat to erosion control. The U.S. Highway Administration has developed erosion control techniques using brush and silt fences and these are part of their temporary erosion control plans. In northern Saskatchewan, they leave all their brush at the side of the road. Forestry people are concerned about the fire hazard but in Saskatchewan, at least, they believe that it's a technique that should be given serious consideration.

This slide shows a more elegant form of silt control - ditch blocks on the Liard Highway near at Poplar River (Plate 20).

Foreslopes at Streams and River Crossings. Generally throughout the Yukon forslopes are constructed too steeply. Silty sandy material in excess of 30 degrees is far too steep. Some research in the Yukon shows that even 30 degrees is too steep. Nevertheless, it is felt that because of the increased cost, the 30 degree guideline, with rip-rap is the best approach. Most of the material shown in these slides is going to find it's way into fish streams before long (Plates 21-23).

This slide shows the use of rip-rap on the Liard Highway (Plate 24).

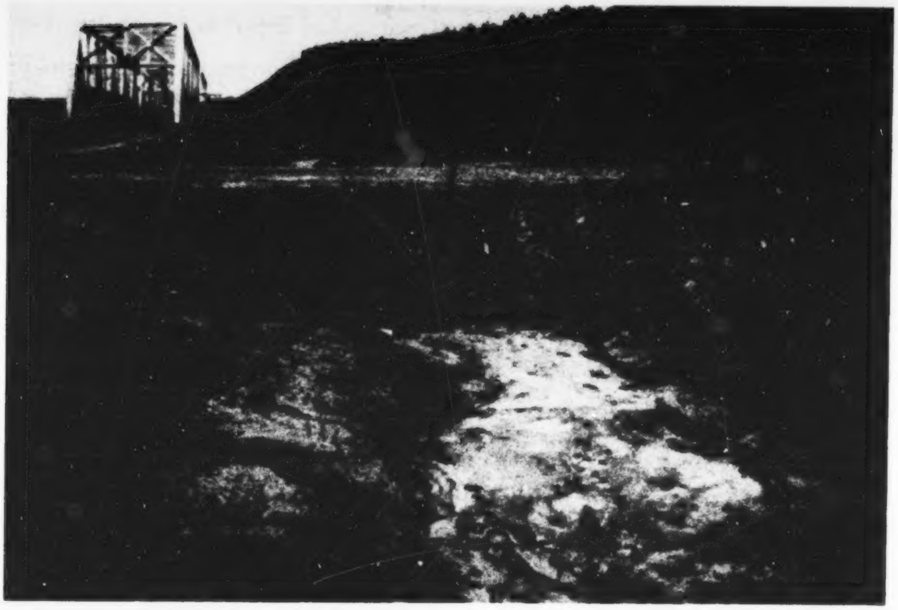


PLATE 17 DITCH SILTATION, ALASKA HIGHWAY.

PLATE 18 UNMITIGATED EROSION PROBLEM AT STREAM CROSSING.

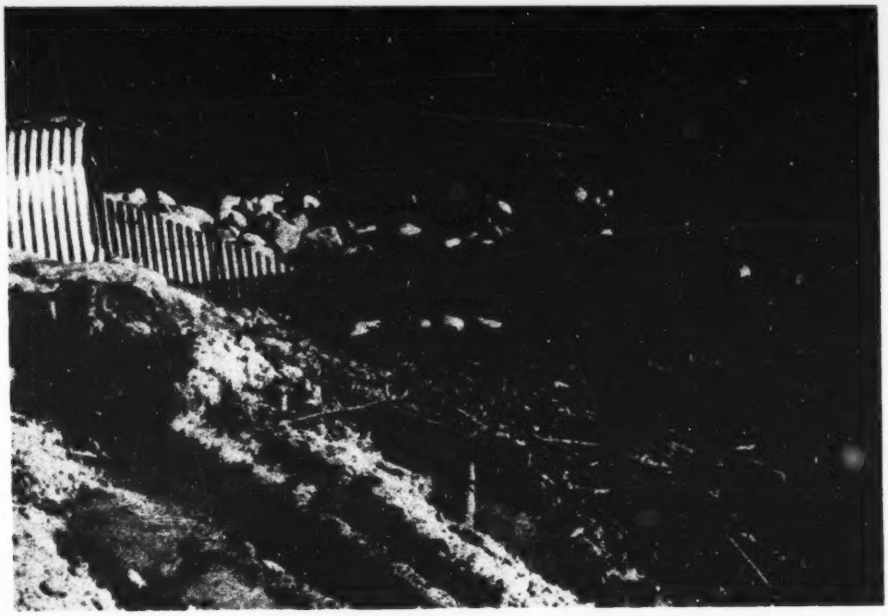


PLATE 19 UNMITIGATED SILTATION PROBLEM AT STREAM CROSSING. NOTE HOW SLASH, INADVERTENTLY LEFT AT SIDE OF ROAD, TRAPS SEDIMENT.

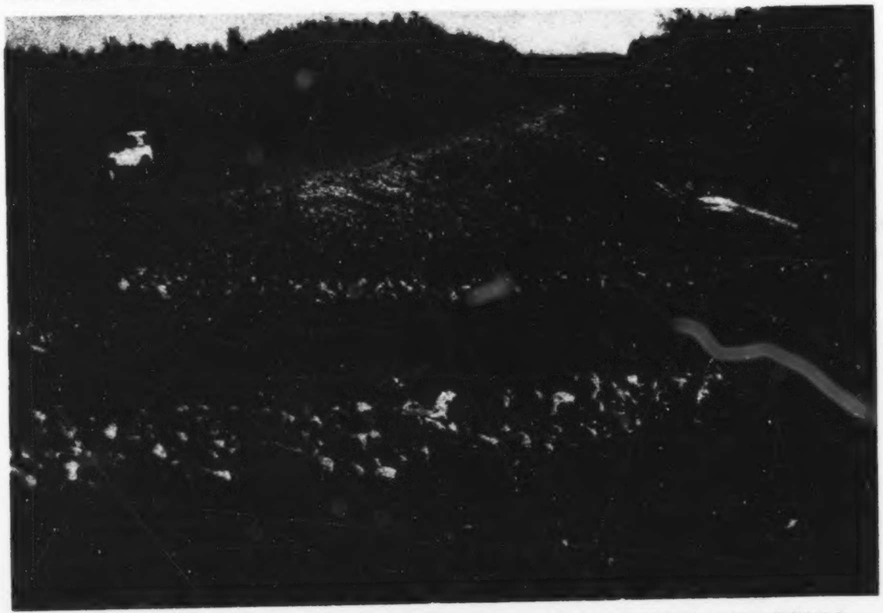


PLATE 20 DITCH BLOCKS TRAP SEDIMENT AT POPLAR RIVER CROSSING, LIARD HIGHWAY.

PLATE 21 STEEP, HIGHLY ERODIBLE FORESLOPE.

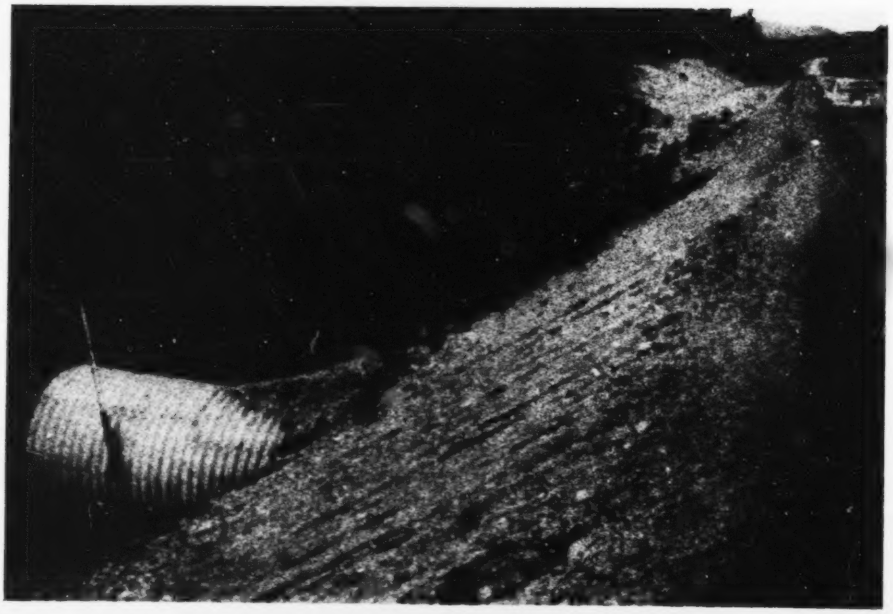


PLATE 22 STEEP FORESLOPE AT STREAM CROSSING.

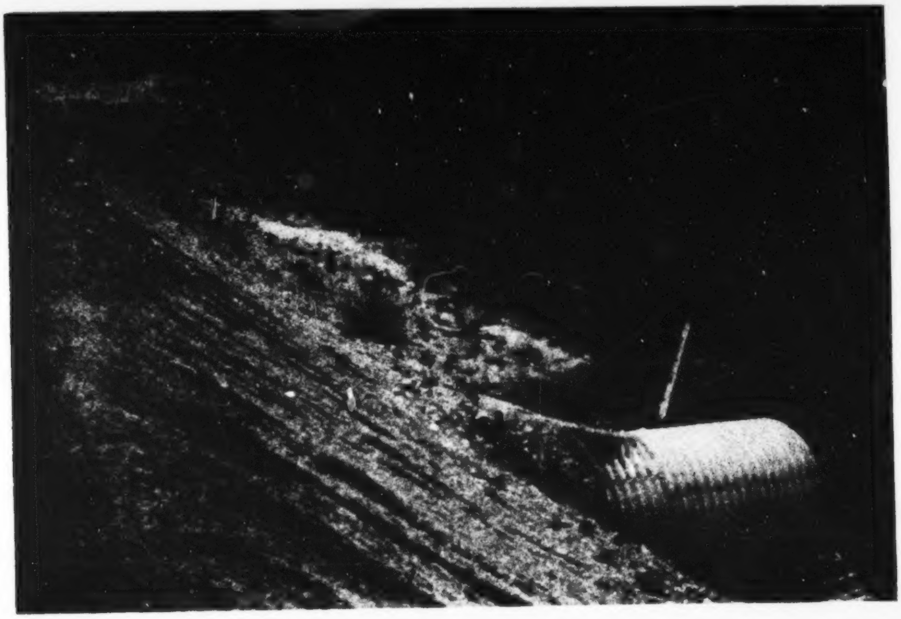


PLATE 23 STEEP FORESLOPE AT STREAM CROSSING.

PLATE 24 RIP-RAP ON FORESLOPE AT STREAM CROSSING, LIARD HIGHWAY.

Shoreland Disturbance In The Vicinity Of Stream and River Crossings. Ideally, a minimum environmental disturbance policy should be adhered to in the vicinity of all streams and river crossings. In many instances the amount of disturbance in the vicinity of stream and river crossings is actually greater than in other areas. I appreciate the need to get crossing structures in place but one can argue about the amount of disturbance observed. In this particular case (Plate 25) there was a problem with waste fill disposal. It was left right by the stream and most of it will eventually find it's way into the water. This slide shows the same thing (Plate 26). It's not that difficult, surely, to develop environmental stipulations which will meet the needs of those who have to get the crossing structure in place and those who have a mandate to protect the environment. Just leaving a buffer (Plate 27) along stream banks in areas which do not have to be cleared right to the streams edge can help enormously. On the Shakwak project they hand-cleared the vegetated banks of all fisheries streams and there was no vegetation removal until the culvert was installed.

This slide shows the use of rip-rap along shorelines to protect the streams from sediment (Plate 28).

This slide (Plate 29) shows a bridge crossing on the Howards Pass Access Road. There's a slump in the approaches to the bridge (Plate 30). A lot of the material is getting into the river, which may or may not be significant in terms of the fisheries resource but erosion control is required. I don't believe, from the limited discussion that I've had, that the problem is that serious, but, it certainly needs to be dealt with.

Discussion

RR The subsidence resulted because the fill is new and probably had ice in it. It's a normal and accepted occurance. Maintenance staff will return and fill it up when it's compacted itself.

RB That type of remedial measure, if taken in conjunction with the appropriate erosion control techniques, may be all that is required.

PLATE 25 EXTENSIVE TERRAIN DISTURBANCE AT STREAM CROSSING, LIARD HIGHWAY.

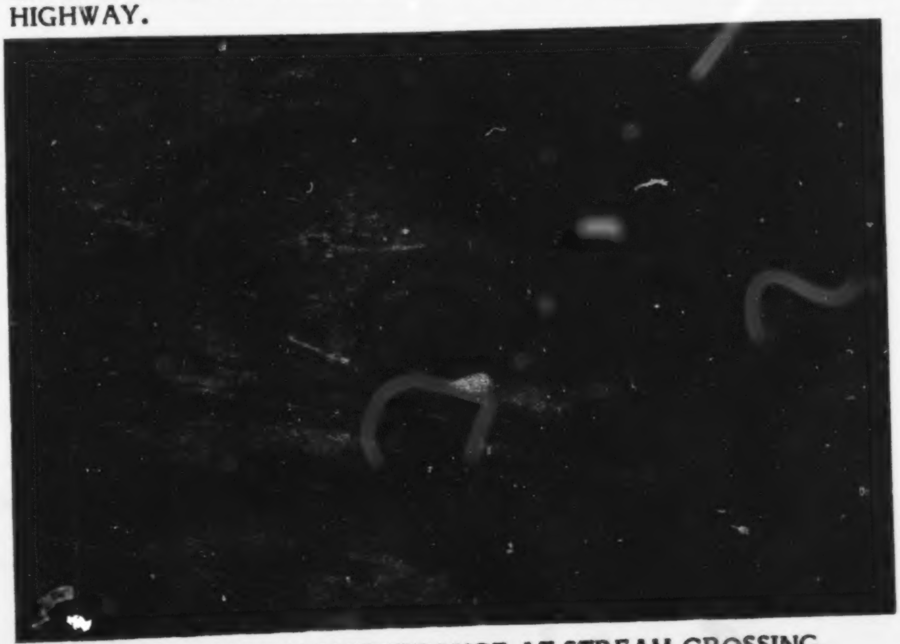


PLATE 26 EXTENSIVE TERRAIN DISTURBANCE AT STREAM CROSSING, ALASKA HIGHWAY RECONSTRUCTION.

PLATE 27 NARROW VEGETATED BUFFER LEFT ALONG STREAM BANK AT HIGHWAY CROSSING. IDEALLY, A WIDER BUFFER OF TREES COULD HAVE BEEN USED.

PLATE 28 RIP RAPPED AND VEGETATED STREAM BANKS AT ALASKA HIGHWAY STREAM CROSSING.

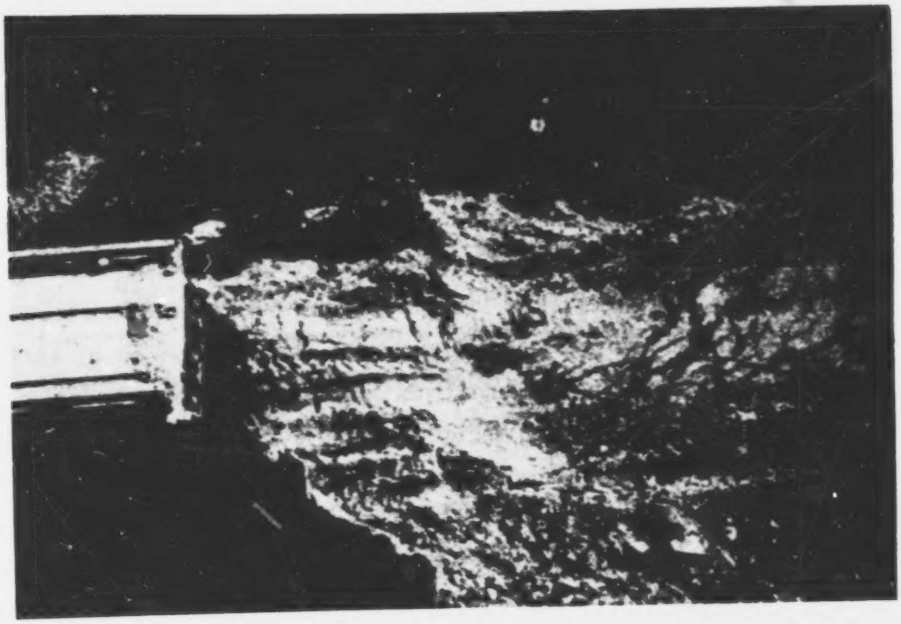


PLATE 29 ROAD SETTLING IN BRIDGE APPROACH, LEADING TO POTENTIAL EROSION PROBLEMS, HOWARDS PASS ACCESS ROAD.

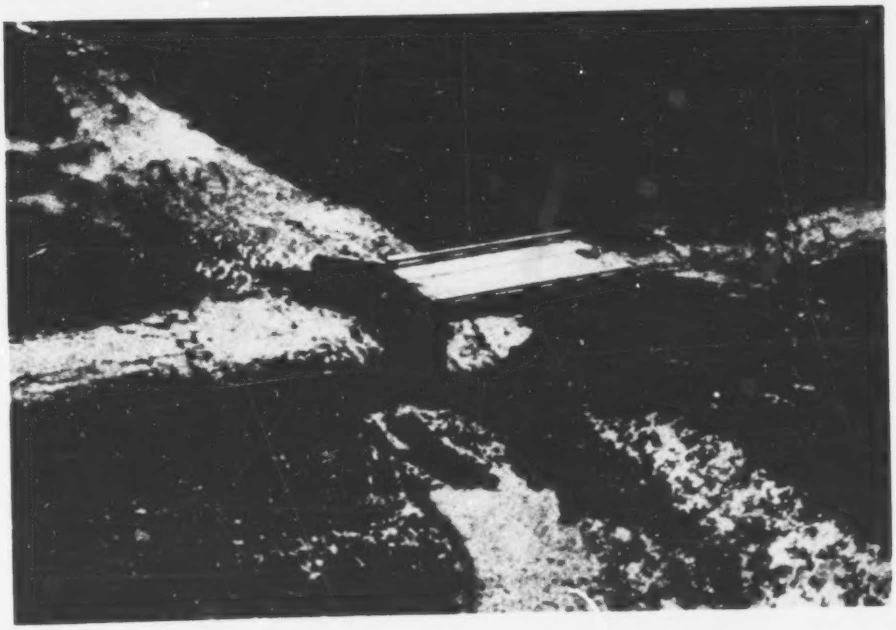


PLATE 30 AS FOR PLATE 29.

Incidently, Rolley is going to talk about other kinds of crossing structures. This slide shows one (Plate 31). It's a timber support Bailey bridge on the Liard Highway. They were also used on the Trans-Canada highway when traffic levels were low and are used now in northern Saskatchewan. Since traffic levels are low throughout the two territories, Bailey bridges seem a viable type of crossing structure to use. It is certainly ideal from an environmental protection standpoint. All the erosion control problems that we looked at earlier, are non-existent here. Alternatives such as this should be given more serious consideration when deciding amongst alternative crossing structures. In fact, DIAND commissioned a report by Damas and Smith to provide a means for looking at the environmental as well as the engineering and economic cost and benefits of alternative crossing structures in the north. Their report can be applied with a fairly limited amount of site-specific data, and I recommend the report to you.

PLATE 31 BAILEY BRIDGE, LIARD HIGHWAY SHOWING UNDISTURBED STREAM BANK VEGETATION.

RR Erosion control is a big topic. I was always impressed with the freeway between St. Catherines and Kingston. It's a well designed road and the banks are all grass. You can have a cloudburst there, drenching the freeway and 5 minutes later, the erosion's under control. But I don't know where you could get the money to do that kind of thing in the Territories. The only way to really solve this kind of problem is with an Environmental Control Board. I attended many such meetings in Ottawa, when the engineers, ministers and scientists got together and did everything but throw rocks. It's really the only way to get the answers. Up here you see, we have the water board with specific authority, and the land people and forestry off on the side trying to do their thing. The answer, as far as I am concerned, is to have an environmental control board, assemble these people and battle it out. Where are the funds to do erosion control, that's the point. There's no use talking terms or specifications unless you've got somebody supplying money. My proposed Environmental Control Board would ensure that wildlife and fisheries interests and the public were represented.

RB I recognize the funding problem and that is one of the reasons I suggested the use of brush control. The amount of effort that goes into disposing of that brush could be translated into erosion control, though I can't put a figure on the additional cost. Also, I'm only talking about erosion control at stream and river crossings, not every mile of road. If you accept the argument that the additional money that is required to do this limited type of limited work is not needed, then there is no need for this workshop. What's the point? If you're not agreed that a limited amount of erosion control at stream and river crossings is needed then there's no point for much else in environmental protection.

RR That's the issue. Everybody agrees that erosion control is needed but are we doing the best with the money we've got and the people we've got?

DW It seems to me that a big problem with road construction is the lack of pre-planning at crossing sites. For example, I think some of your problems could be solved by clearing around the streams initially, so that you don't disturb that mineral soil. You also talked about having brush next to the stream. A smaller right of way at a stream crossing is an excellent idea but you need more of a buffer than just a few feet of trees (Plate 27) because invariably those trees will fall into tne water with wind erosion and leaving the stream bank unstable. In Saskatchewan we found that if the area around the stream was winter cleared, growth during the next spring was quite good. The key reason seems to be leaving the top soil undisturbed. Preplanning is needed to indicate when and where you're going to do the clearing.

RB My recommendation is that there be some planning. In the case of erosion and sediment control I see two kinds of plans. A temporary plan that would be instituted to do the kinds of things you just suggested and then later on when construction is completed a more permanent type of plan. I think the initiative has to be taken by government to say that this is required. Some thought should be given to this sort of thing, even if only at a generic level. Later you could tailor these general statements for specific resource road projects. The purpose of these plans would be to identify the problems and define effective and economical measures which can be used in conjunction with construction activities to prevent or at least control erosion and sediment. There's no lack of information on what needs to be done. Temporary and permanent erosion control plans are advocated by the U.S. Highway Administration, for example.

I suggest that structural measures for temporary erosion control should include brush barriers and perhaps also silt fences. You can argue cost and effort but if we limit silt fences to fish streams you do not require a lot of effort and resources. Really, you're talking about the protection of the fisheries resource. If you destroy that resource in locations where people have access to streams you are surely having an adverse affect on the northern economy. So there are spin-off implications to what we're discussing here. I also recommend that there be improved co-ordination of Federal surveillance activities. DPW (Yukon) has said, "look we build highways, that's one or our job in the north and we think we do it well. If people have environmental concerns they should do the necessary surveillance and tell us what the problems are". One of the obvious difficulties is deciding who should do the survey. We've got a number of agencies that do environmental work in the north, DFO, DINA, DOE and GNWT. The impression I got from the work I did on the Liard Highway is that there has to be a better co-ordination of surveillance activity amongst these groups so that people speak with one voice when they're talking to the chief engineer on the project. The engineers I talked to on the Liard Highway would like to have just one voice speaking to them on environmental problems and to tell them what they think should be done, rather than just hear blanket condemnations of the project. That doesn't help anybody.

RR When the Mackenzie Highway was to be built they established a coordinating position for that purpose in Yellowknife. The idea was to co-ordinate highway inspection activity and it probably would have worked but the position was done away with.

CS I suspect that there's probably not much interaction from the public prior to and during road construction in the north.

RR No there isn't, and this is one of the reasons why I recommend very strongly, this idea of the Environmental Control Board. You see, the Water Board has a very informal procedure. They have hearings only when they think hearings should be held. But there should be a systematic approach toward public hearings.

RB This idea was discussed at length in the Yukon. DPW had an environmental co-ordinator for the Shakwak project, and it worked very well. That position has been done away with. They've substituted a regional environmental co-ordinator to look after all projects in the North and act as an intermediary between the environmentalists on the one side, and the project engineers on the other - to translate and make sure that the messages from the two groups are getting across.

DW A system, has been established over the last 4 years in Saskatchewan called the Environmental Assessment Secretariat. All roads projects in the North, have to go through the Department of the Environment, Environmental Assessment Secretariat. If it's a major road it has to have a complete environmental impact study. Certain aspects are subject to stream crossing guidelines. Specific crossings may be given to an approving agency, say fisheries, to ensure that the crossing structure meets the requirements of the Fisheries Branch. We don't have much input into a lot of minor pulp roads. But the idea here is that pre-planning in most cases really solves a lot of problems. Our problem is that we don't, as fisheries staff, have the funds to get into these remote areas to find out if these rivers and streams are important from the fisheries standpoint although we do find out a little when consultants do studies. So again, it's the pre-planning and the idea of a co-ordinating body that are important. We find that all the companies that are going through an Environmental Assessment Secretariat, really appreciate that. Because they can't deal effectively with all the water rights, Boards, Fisheries, federal government regulations etc. It really is a help to us too.

OPENING UP THE NORTH: A DECADE OF CHANGE

by

Lee Harding

Before I begin I would like to emphasize that this paper does not represent an EPS or Departmental viewpoint. It is a review of the past decade of linear facilities environmental impact assessment with emphasis on roads. Conclusions and recommendations are provided.

In 1905, Superintendent C. Constantine of the Northwest Mounted Police, along with thirty-one officers and constables and sixty horses, built the first Alaska Highway. It wasn't called that, it was called the Police Road. A route to the gold fields of the Klondike, it was built to the highest engineering standards of the day with bridges, corduroys and rest cabins.

Environmental standards were, of course, non-existent. Instead of going around the mountains as it does today, Superintendent Constantine went straight over every mountain range he came to from Fort Saint John to the Yukon Telegraph Trail. They crossed and re-crossed drainages. They went through winter moose range, grizzly bear denning areas, Stone's sheep lambing areas and caribou migration routes. They made cuts in steep, unstable slopes and in the high mountain passes they removed the protective mat of vegetation overlying permafrost. Surely, in such a delicate, virgin northern wilderness this road must have been an environmental catastrophe. But one thing was different about the road. Although it was built, no one ever used it. In 1970, I spent a summer travelling back and forth on the old Police Trail (Plate 1) from the Peace River prairie to the top of the Rocky Mountain Divide, by horseback, the way Superintendent Constantine had gone. It was so overgrown that except for the odd cut on a dry sidehill, it could have been a game trail. The meadows were literally littered with trophy-sized moose antlers, shed during the winter and slowly sinking into the sedges. Every cow moose had two calves; some had three (Plate 2). On most days above timberline I saw over a hundred mountain caribou. I was guiding at the time and my clients found plenty of record class Stone's Sheep to choose

PLATE 1 THE ROUTE OF THE OLD POLICE TRAIL THROUGH NORTHERN BRITISH COLUMBIA AS THE FIRST INLAND ROUTE TO THE KLONDIKE GOLD FIELDS, WITH THE SUMMIT OF MT. LADY LAURIER IN THE BACKGROUND. THE ROAD IS BARELY DISCERNABLE AFTER SEVEN DECADES.

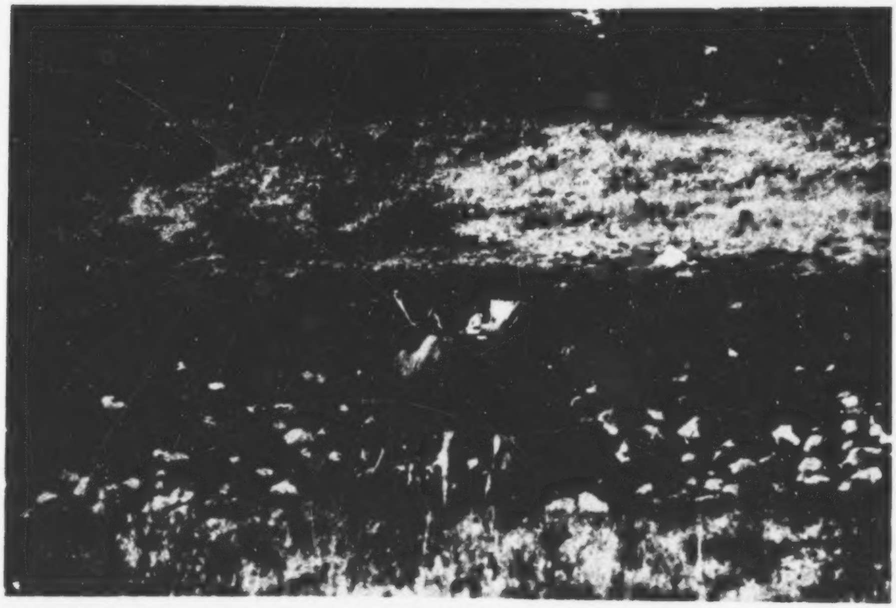


PLATE 2 ALONG THE CUTS OF THE OLD POLICE TRAIL, MOOSE USE MINERAL LICKS. ENVIRONMENTAL DEGRADATION RESULTING FROM THE ROAD IS NOT APPARENT TO SPORTSMEN.

from. The grayling and dolly varden were numerous and voracious. There was no long term environmental impact from that road. And that experience convinced me that a road, by itself, is not necessarily environmentally harmful. I wish I could say the same for some other northern roads.

Ten years ago, following the discovery of oil and gas in the Beaufort Sea, construction started or re-started on three major roads to open up the north: the Liard, the Mackenzie and the Dempster, as well as some shorter resource roads. Almost as quickly, construction was stopped on all three while we studied the environment, not only of the roads, of course but also of various pipeline corridors which the roads traversed. In 1972 I worked for industry in assessing the impact of the Mackenzie Valley Pipeline, which was then the largest environmental impact study ever undertaken. Of course we studied the undisturbed environment on the proposed corridors, but to assess impact we needed to look at some real linear facilities with impacts similar to a pipeline right-of-way (Plates 3-4). We studied everything from single cat trails to winter roads, seismic lines, permanent roads and old abandoned roads; we studied them from every aspect: big game, furbearers, waterfowl, vegetation, terrain, drainage, revegetation, you name it. If it walked, crawled, swam, flew or grew across any kind of a linear facility in the north, we had its name in our notebooks. In that year - 1972 - I counted over seventy biologists in the Mackenzie Valley from industry, government and universities, not to mention the engineers, geologists, hydrologists and so on, all assessing the environmental impact of linear facilities. Well, you all know the pipeline story. After five years and a mountain of data, Mr. Justice Thomas Berger said that we could build a pipeline and all the roads we want up the Mackenzie Valley, but that no such corridor should ever be allowed to cross the northern Yukon. He suggested that we consider an alternative route following the Alaska Highway.

In 1977 we all found ourselves in Whitehorse, attending environmental hearings into the Alaska Highway Gas Pipeline. During the course of these hearings government expert after government expert picked up the

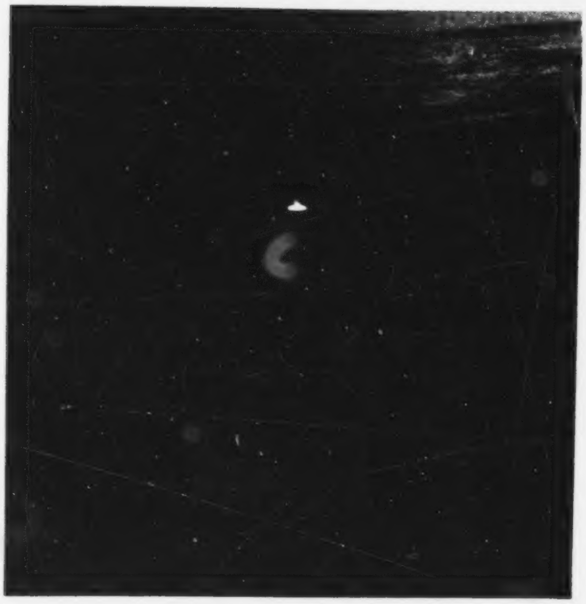


PLATE 3 A WINTER SEISMIC LINE ON BATHURST ISLAND, N.W.T. IS BARELY NOTICEABLE BUT CAN AFFECT THE MOVEMENTS OF CARIBOU.

PLATE 4 SEISMIC BLASTING CAN DISRUPT MUSKOX AND PEARY CARIBOU AT CLOSE RANGE, BUT STUDIES HAVE SHOWN LITTLE GROSS REACTION BEYOND A FEW HUNDRED METERS.

microphone and said that he could not assess the impact of such a northern pipeline because he had no data. Carl Surrendi, my boss at the time, disagreed. He felt there was plenty of data. Why, just look at all the highways and pipelines and cutlines criss-crossing the north, and all the studies that have been done (Plate 5). Why not, he proposed, bring together all the completed studies of existing linear facilities to find out what the impact was and make some extrapolations? And if, after reviewing all available information, we still could not assess the impact, why not study in further detail some existing linear facilities to see what the actual impact was? Mr. Surrendi's proposal was accepted. Beak consultants were contracted to bring together all available information, whether published or hidden away in scientists' files on the actual, measured environmental impact of northern linear facilities. It was hoped that by bringing this information together in a useable form for future projects we could avoid the spectacle of standing up and telling a commissioner after five years of study, we had no data. As a first phase, the contractors compiled a catalogue of over 1700 published references on northern linear facilities, each keyed to a map of roads, pipelines, transmission lines and so on. Then they undertook a critical review of this literature as well as unpublished data in government and other files to answer the question, "What happened to the environment after northern linear facilities were built?". They were about to undertake a second phase of the project, to study in further detail a few existing facilities to fill in some identified data gaps and it is to my great regret that the project was cancelled because of funding difficulties. Their report on Phase I, in two volumes, was published in May, 1979.

What, really, are the environmental impacts of northern resource roads? You are all familiar with such terms as permafrost subsidence, mass wasting, fluvial erosion, modification of surficial and ground water regimes, alteration of plant and animal communities, habitat degradation, interruption of fish and wildlife migration, over exploitation of fish and wildlife resources, and direct mortality on highways. The consultants documented many instances of all of these (Plates 6-8). These impacts are real and they are serious and they can happen with every

PLATE 5 A RESOURCE ROAD TO THE LUPINE MINE, CONTWOYTO LAKE, N.W.T.

PLATE 6 PERMAFROST SUBSIDENCE AND PONDING RESULTING FROM OFF-ROAD TRAFFIC.

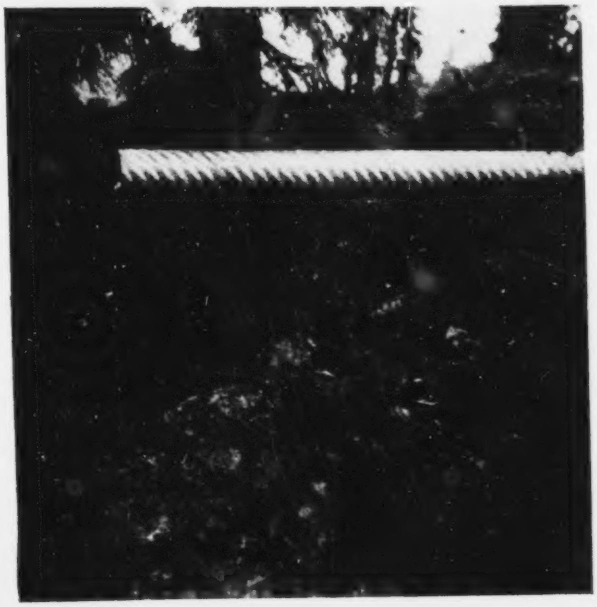


PLATE 7 INCORRECT POSITIONING OF CULVERT LEADING TO MASSIVE EROSION.

PLATE 8 MASS WASTING OF A CUT IN PERMAFROST RESULTING FROM FAILURE TO INSULATE CUT FACE.

resource road built in the north. That's the bad news; now here's the good: For nearly every environmental impact, there is a mitigative measure. We have the technology to prevent mass wasting. We can prevent permafrost subsidence. We can prevent erosion and siltation. We can regulate hunting. In 1976, I had the pleasure, under Carl Surrendi's direction, of coordinating the development of recommended environmental standards for the construction of a Mackenzie Valley gas pipeline. Detailed sections on resource roads were provided. This document had, of course, the benefit of several excellent, previous compilations of mitigative measures for northern resource roads, including those by the Environment Protection Board, Fisheries and Marine Service, and Environmental Protection Service. In 1977 the grandaddy of all was published: Mr. Justice Thomas Berger's volume II, Terms and Conditions, which of course includes sections on roads.

As fas as I know, aside from locally important sensitive areas, there are only two environmental impacts of any consequence that we cannot mitigate: 1) we still do not know if roads can be compatible with migratory caribou and 2) we do know that roads are never compatible with wilderness. For the rest, all we need is adequate site-specific environmental information to reveal the problems, and adequate environmental design to solve them.

So if we know so much about mitigating the environmental impacts of northern resource roads, why all the fuss? Well, knowing how to solve environmental problems and being able to do so are two different things. The existing regulatory apparatus forces delays and frustrations on resource developers and is not adequate to protect environmental values. To illustrate that, let's look at some highway case histories. First, the Dempster Highway (Plate 9). Construction of the Dempster Highway was probably the most interrupted of any major highway in Canada. It was, and remains, probably the most controversial, environmentally. Started in about 1954, its design consisted of little more than one aerial flight from Dawson City to Fort MacPherson to locate a route. After that the building started and stopped over the next 2 decades. In 1972 I examined a section between Arctic Red River and Inuvik which had been

PLATE 9 ICING ON THE DEMPSTER HIGHWAY, AT THE HIGHEST PASS IN THE RICHARDSON MOUNTAINS.

abandoned because of all the washouts and terrain problems, and a worse mess I've rarely seen. By 1973, when I first surveyed the rest of the route, it had only made it as far as the Eagle plains. Construction halted while Berger deliberated: he found, after considerable expert testimony, that the Dempster Highway was a distinct threat to the population of caribou that annually cross the Porcupine River. He found, further, that in not a single case worldwide where a road or a railroad has been built across the range of migratory caribou or reindeer, has the herd maintained it's numbers.

Despite objections from many public interest groups and government agencies, Dempster Highway construction was started again. The Environmental Assessment Panel for the Alaska Highway Gas Pipeline recommended in 1977 that an environmental impact assessment of the Dempster Highway be undertaken immediately. Construction still went forward. Then the Department of Environment asked that a cost-benefit analysis of the highway be prepared. Still the bulldozers worked. The

Yukon Game Branch protested the highway but they were powerless to do anything but hire a biologist to record the impact. A special task force was formed to find if, and how, the highway could be compatible with the caribou.

In March of 1977 I drove the incompleted portions of the Dempster Highway by skidoo, in the company of a Dene man from Fort MacPherson. He told me that already the caribou were harder to hunt because they avoided the area of the highway. In 1979, I watched the first tourist cars arrive in Inuvik. I can tell you that Canada has lost a good portion of its last great wilderness because of the Dempster Highway. Only time will tell if we will lose the caribou too (Plate 10).

PLATE 10 THE ROAD TO CAMLAREN MINE, GORDON LAKE, N.W.T. WHERE HUNTERS TOOK OVER TWO THOUSAND CARIBOU IN A FEW WEEKS DURING 1980. MANY CARIBOU, SUCH AS THIS ONE, WERE LEFT TO THE FOXES AS HUNTERS PURSUED CARIBOU CLOSER TO THE ROAD.

Case study number two is the Liard Highway. In July 1972 I was camped under the highway bridge at Jean Marie Creek while I was busy with pipeline environmental studies. A Dene man came into my camp and told me that the Liard Highway construction crew had put in two giant culverts on the Poplar River. He had seen the whitefish trying and failing to get past the culverts to spawn upriver. All the fish in the river, he told me, were in a big pool below the culvert. Enough for him and all of his dogs, and all of his families' dogs for all winter. "I won't net them", he told me, "because then there'd be none next year". But with those culverts there, there won't be any anyway. And then what will I feed my dogs?" I made enquiries and found that Territorial biologists were aware of the problem but had no authority over either the road or the fish. I did find, however, that federal fisheries were aware of the problem. The Fisheries and Marine Service has the authority of the Fisheries Act, which makes it illegal to block fish migrations. I forgot about the problem knowing that the matter was in good hands. Soon after, construction was stopped while we awaited Berger's inquiry.

Five years later, in 1977 as Chairman of the Regional Transportation Committee of Fisheries and Environment, I was asked to advise on whether an EARP referral was necessary before completion of Liard Highway. The committee ascertained that the overall impact of the Highway would be slight, but that Fisheries had been nagging DIAND about the Poplar River crossing for some years without success. We replied that an EARP referral was not necessary, but that the Poplar River crossing should be upgraded to allow for fish migration before proceeding with highway construction. This advice was transmitted to DIAND at the Deputy Minister level, as I recall, and soon afterward we were advised that DIAND had identified funds for a proper bridge at the Poplar River. But it was never implemented. It has now been a decade since that crossing was built, and still my Dene friend has no fish for his dogs.

Case history number 3. The Howards Pass Road (Plate 11). A small resource road to serve a single user, the road to Canex Placer's property at Howard's Pass was authorized and licensed by the Department of Indian Affairs and Northern Development. The approval was given, however, over the objections of federal fisheries who were concerned

PLATE 11 THE VALLEY OF THE LITTLE NAHANNI RIVER BEFORE CONSTRUCTION OF THE HOWARD'S PASS ROAD.

that under-design of some culverts and bridges and other design problems, would lead to impacts on fish resources. When their representations at the local Interdepartmental Committee in Yellowknife were to no avail, the matter was referred to the Fisheries and Environment Regional Transportation Committee. But the Department of Indian Affairs and Northern Development was determined to carry out their mandate and the road went forward. The road was a disaster. When the permafrost soil was exposed it started melting, assisted by continual and unusual rains. On cut banks, the cut scars migrated uphill, in places for hundreds of meters. On level ground the disturbed soil turned into a muddy soup that no amount of gravel could fill. Whole sections of the road collapsed and slid into Flat Lake. In 1977 the contractor told me that the road design was poor: it followed the worst terrain conditions on the wrong side of the valley; he was forced to cut when he should have been filling; (Plates 12-13) he was required to cut into steep slopes instead of following a more level route

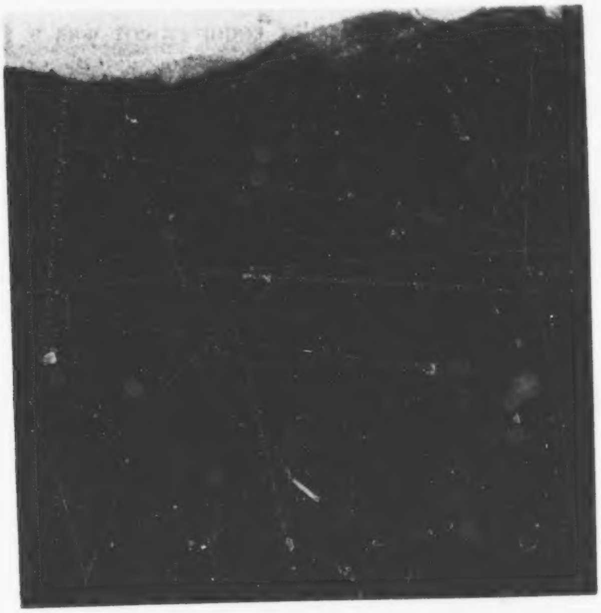


PLATE 12 THE HOWARDS' PASS ROAD DEMONSTRATING INTEGRITY OF PERMAFROST WHEN ROADBED IS CONSTRUCTED BY FILLING WITHOUT DISTURBING THE MAT OF VEGETATION.

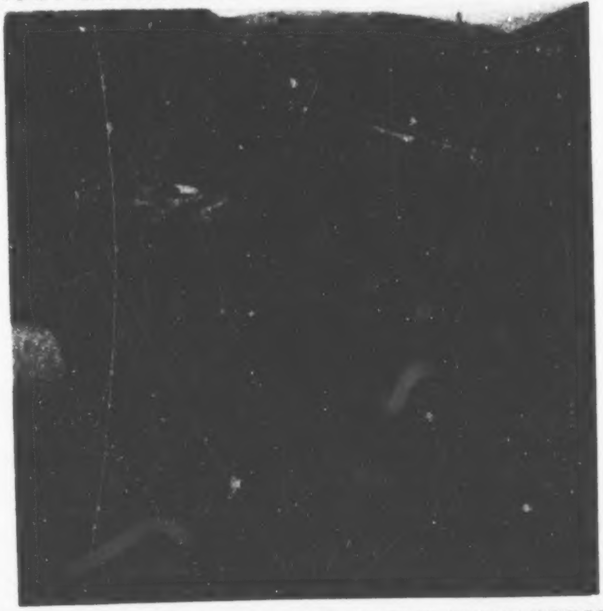


PLATE 13 NEAR THE SAME LOCATION, IN THE SAME PERMAFROST SOIL, SAME SLOPE AND ASPECT, BUT WITH THE ROADBED CUT INSTEAD OF FILLED AS IN NO. 6.

near Flat Lake (this particular requirement was a fish protection near Flat Lake (this particular requirement was a fish protection measure; and the culverts were undersized which fisheries had been pointing out for a year). By 1979, out of some two dozen culverts and bridges installed, only one had not washed out (Plates 14-15).

Was this an environmental catastrophe? Ugly, yes, but all roads are ugly during construction. The long term impact will depend not on the quality of the environmental report that preceeded approval, nor on the conditions of the approval, nor yet on the continued vigilance of federal fisheries officers. The impact will depend on whether the Northwest Territories Games Branch can develop the mechanisms and staff to manage the big game populations being exploited by the new access. And this is the problem with many resource roads: the real environmental impacts have nothing to do with the environmental approval process. The agencies responsible for managing local resources and with responsibility to local people have no authority over resource roads.

Case history number 4. The Mackenzie Highway. Before the Mackenzie Highway was extended from Fort Simpson to Inuvik a thorough environmental impact assessment was commissioned by the Department of Public Works. With that document in hand, the road was designed to mitigate identified impacts, and the design was submitted for review by an interservice committee of Environment Canada. Following their approval, Fisheries designed and implemented a long-term study to monitor the actual impact of the road. This is so far the first and only northern resource road which has had the benefit of adequate environmental impact and design. And this is the road they chose not to build. I ask you: Does that make sense?

Conclusions. 1. In the past decade, the state of the art for protecting the environment from resource roads has come of age. In most cases there is no need to assess the environmental impact of proposed northern resource roads because the kinds of impact which can be expected are known. What is needed, is proper environmental design, thorough inspection during construction, and more intensified management of the

PLATE 14 A PLUGGED DITCH CULVERT, RESULTING FROM MASS WASTING OF A CUT FACE IN PERMAFROST. THIS CULVERT SUBSEQUENTLY WASHED OUT.

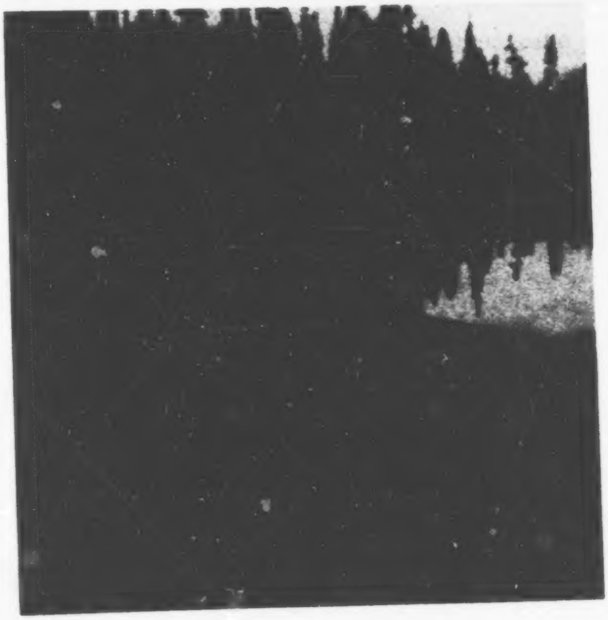


PLATE 15 EROSION RESULTING FROM NO. 12 ABOVE.

resources to which access is being provided. 2. The Department of Indian Affairs and Northern Development has demonstrated itself incapable of protecting the northern environment from roads. Small wonder, since they are a development agency and the word environment does not appear anywhere in the Northern Inland Waters Act, the chief licensing authority for river crossings. 3. The Department of Fisheries and Oceans has demonstrated itself incapable of protecting the northern fisheries resource from roads. They have the knowledge and the authority but not the will. 4. The Department of Environment has demonstrated itself incapable of protecting the environment from northern roads. They have the expertise, but lack both commitment and authority. 5. Both Territorial Governments have demonstrated that they are incapable of protecting the environment from resource roads. They have the expertise, although they may be short of staff; they have the will; but they lack the authority. 6. Unfortunately, the preceeding agencies are all we have to work with, so we'll have to make do with what we've got.

Recommendations. 1. Every new road means more work for environmental management agencies. This should be recognized at budget and staff allocation time. 2. We should identify areas of importance to migratory caribou and areas of national or regional significance for wilderness values, and we should not build any roads there. The best agencies to undertake this task are the two Territorial Game Branches and Parks Canada using mechanisms already developed and following initiatives already undertaken. Until this is complete, there should be a moratorium on northern resource roads. 3. For other areas, approval in principal should be automatic. Final approval should be withheld until the appropriate environmental management and protection agencies are satisfied that sufficient environmental data has been obtained and that environmental design is adequate. 4. The Territorial Lands Act and the Northern Inland Waters Act should be administered by the two Territorial Governments. The authority and staff should be transferred from the Department of Indian Affairs and Northern Development without delay (Plates 16-19).

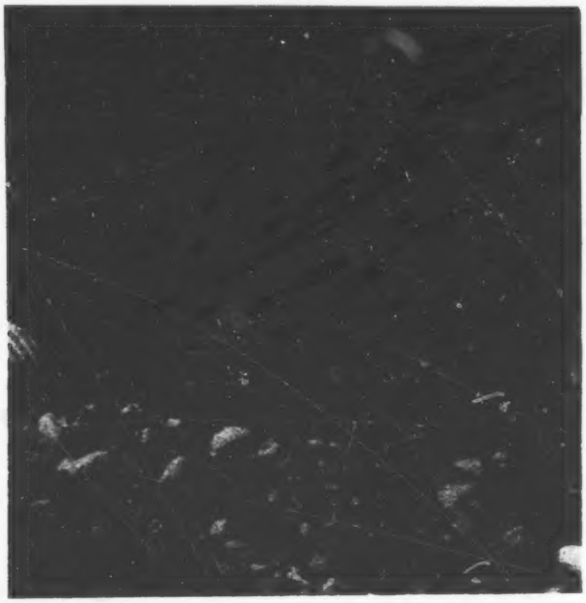


PLATE 16 ASSISTANCE FROM BEAVERS ON THE HYLAND VALLEY ROAD, YUKON. THE BEAVER DAM MEDIATES FLOW THROUGH THE CULVERT, REDUCING THE CHANCE OF A WASHOUT. IN SIMILAR CIRCUMSTANCES, THE BEAVER DAM COULD PLUG THE CULVERT, CAUSING A WASHOUT.

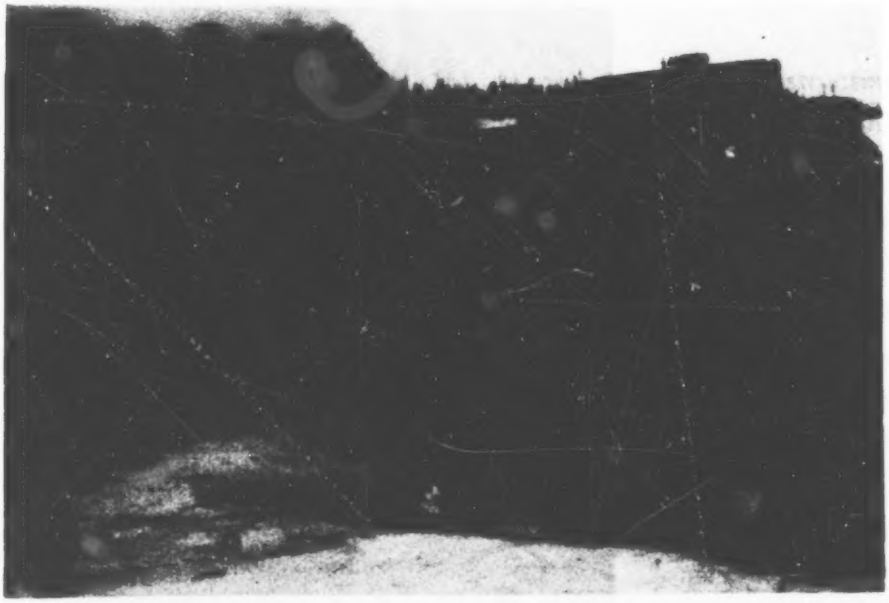


PLATE 17 THE CAMLAREN MINE ROAD IN WINTER, AS AN ENVIRONMENTAL PROTECTION OFFICIAL, DAVE SUTHERLAND, BURNS OFF DIESEL FUEL SPILLED WHEN A TRUCK WENT THROUGH THE ICE.

PLATE 18 WHEN PROTECTED, ANIMALS OFTEN BENEFIT FROM NORTHERN ROADS, SUCH AS THESE MOUNTAIN GOATS USING A ROAD CUT AS A MINERAL LICK IN JASPER NATIONAL PARK.

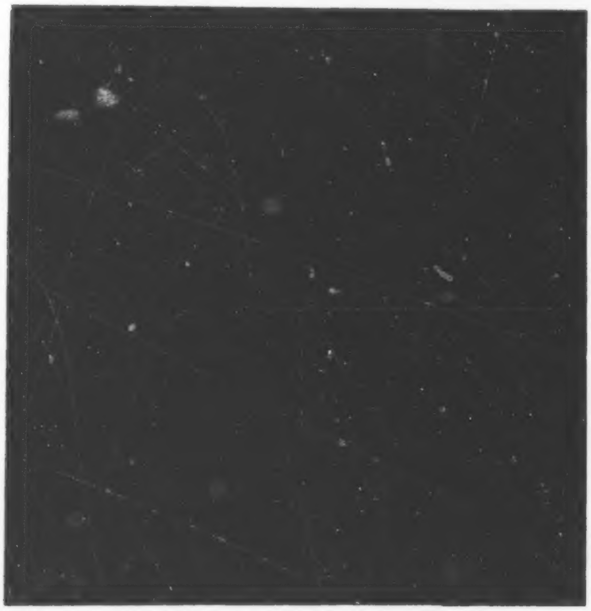


PLATE 19 A BLACK BEAR USES A ROADSIDE IN JASPER NATIONAL PARK.

Discussion

RR The one flight location of the Dempster is an exaggeration.

LH Obviously, I'm speaking a bit tongue and cheek. There was more consideration given to locating a route for the road, but not much more.

RR Do you think the Dempster should have been built or not, Lee?

LH It should not have been built.

WB Our office was involved quite closely in the approval process for the Howard's Pass Access Road and I think the issue for that road and all new types of resource road developments in the north is whether there is a need for the road at all, going into wilderness areas? In hind sight the Howard's Pass Access Road was probably not necessary at all. Now we're left with a washed out small access road with some terrain damage. At Cullaton Lake, they decided to develop that property without a road and everything was flown in. And Cadillac Development uses a winter road to develop their property. Thus, the primary consideration for northern roads is: do we need a road to open up additional wilderness?

CS There seems to be some real concern as to the necessity of constructing some of these roads at all; where do they go and what are they going there for?

RR That's a good question. I think it's only by doing as much possible advance planning that you could answer the question. The reason given for the Canex Road is that they wanted to get 1500 to 2000 tons of storage in for underground exploration. They did have an airstrip up there and I think they could have got it in by air. It was alleged that the road would be needed for annual resupply and has been used for that each year.

One thing that should be cleared up is that the Canex Road was not a public standard road, but an initial access road.

LH This slide shows a side-hill cut Rolley, perhaps you'd like to comment (Plate 20).

PLATE 20 A PROPERLY PREPARED, NEARLY VERTICLE CUT, ALLOWING THE OVERLYING MAT OF VEGETATION TO DROOP OVER THE CUT FACE, INSULATING THE PERMAFROST SOIL AND PREVENTING FURTHER THAWING.

RR Some years ago the Finns found that the best way to tackle permafrost was to cut straight through instead of making a big long slope exposed to the sun, then allow it to slough down until it stabilizes. It looks very sloppy but cuts like this cause the minimum amount of environmental damage in permafrost.

LH What your saying Rolly is that if you make a vertical cut, let it slump, keep the ditches clean, then over a few years the overhanging vegetative mat falls over it covering up the ice.

BG So it looks like hell for the first few years but eventually it stabilizes itself, and if somebody was to go into there and backslope it, then you'd compound your problem.

LH I'd like to reiterate a point I made during my presentation for the Howards Pass Access Road. I'm sure in time the road will heal. If any fisheries have been wiped out I'm sure they'll all come back, even though you might have to wait a few years. But the long term impact in my opinion is the fact that the road is there. It provides access to hunting which has nothing to do with the environmental approval process.

MC Environmental isssues have surfaced in the last 2 or 3 decades. The whole process has bogged down in arguments between various agencies and departments. Maybe we haven't involved the construction worker, the design engineer, the environmentalist enough to overcome the problems.

LH I couldn't agree more, and this is why I said that you need proper environmental design. Contractors have to be made aware of the environmental design requirements. You need thorough inspections, and the staff to get up there and make sure the contractors know the problem. Bob Baker showed culverts which were put in improperly, which with no additional expenditure in resources, could have been put in properly.

DW I mentioned the Environmental Assessment Secretariat earlier. One of the things that has to be done is to demonstrate the need for the highway. So you have a cost benefit analysis of what that road is going to do for the people, what it's going to do to the environment, what trade offs are available, plus mitigative measures. In some cases we have had the public come forward and state their particular concerns. This may not cancel out the whole road but it may result in mitigative measures.

JD There's an important point here that we're kind of ignoring, and that's the fact that there are obviously regional differences in terms of the distribution of costs and benefits to a lot of these roads. The costs both short term and probably long term are born by the residents of the Northwest Territories, not the 22 million other Canadians in whose interests we're allowing these kinds of developments to go forward. The other point is that we have to look at the process itself and where the decision making takes place. In the case of a large scale highway development, the decision-making and the decision as to whether or not an EARP review is required is not made in the Northwest Territories, it's made in Ottawa, and when it comes down to the kinds of roads that we actually have control over through our environmental review process in the region, the public has no access to that process. Costs are borne by the local residents who have little or no opportunity for access to the decision making process.

BG I don't think that the solution to the problem is more environmental studies.

LH We don't have to try to assess the impact because, we know what the problems are and we can deduce the effect. What we need is proper environmental design and some environmental studies to find out what the specific problems are in an area.

CS What we should be asking is what type of environment do we want during and after the construction, then ensure that the environmental planning and the money is available for the contractors, to deal with those things, rather than spending millions of dollars to tell us what we already know.

DW What you're saying is exactly what C.S. Holling from UBC has said. He calls it adaptive environmental management. The impact statement itself, is passé. What you need is an integrative process that starts at the pre-design stage, and runs right through to the monitoring phase. It's very easy to mitigate short term impacts to solve those problems. Our real problems are with wildlife because we have no way of quantifying long term impacts.

CS One of the main long term problems you're going to have is access to the resource, whether people hunt and fish or not. If people are around, they're going to change the environment.

WOODEN BRIDGES IN THE NORTH

by

R. Rollefson

I was asked to speak on wooden bridges because I tried to get them built on the Mackenzie and Liard Highways. The objective was to improve the environment for fish, and for other environmental cultural and social reasons. I originally suggested that they be temporary wooden bridges because the elaborate designs that they were producing for the Mackenzie Highway seemed incongrous for the road and it's purpose. They'd design million dollar bridges where aesthetics didn't make any difference and even looking years ahead they seemed out of proportion to the criteria and design for the road. They did build a temporary bridge at the river between Two Mountains, a log crib with Baileys on it.

Some of the pro's and con's of wooden bridges are as follows: First, when a big road is to be built eg. the Mackenzie or the Dempster it usually begins as a tote road. It is put in quickly with temporary bridges and so forth, supplies are brought in and work is begun in a number of different places. The Alaska Highway was built in this way. Many miles of the tote road were incorporated into the eventual Alaska Highway while other stretches had to be rejected. It was in those days that wooden bridges were at their best. The social benefits to the natives in Hire North would be in constructing the bridges, instead of drawing welfare. This was one of the important features, I thought, of this program. I've watched Hire North for many years and I think it's one of the most positive, efforts to get the native people in the north involved in what we are doing. Social benefits also accrue in aquiring new skills. To begin a bridge construction operation all you need is one good superintendent, a crane operator and teams of helpers and labourers from the local population. They would hopefully of course, become trained to be crane operators and pile drivers and in the end, take over the whole operation.

On the Liard Valley we have the best trees in the Territory, and the building of wooden bridges there would seem to be sensible. Wooden bridges cause the least disturbance during construction, and leave the stream beds undamaged for fish passage. Wooden bridges used temporarily give time for further hydrological observations and studies to fill data gaps. On the Liard highway, there were fierce arguments because they didn't have hydrological data far enough back for good planning. But if you build temporary bridges you can use the time to develop better designs for the future. Temporary wooden bridges can be replaced by permanent steel or concrete ones several years after construction is completed thereby phasing funding, design and construction work.

On the Mackenzie Highway, many consultants were employed to design bridges. Principal engineers cost from $100-200 an hour, helicopters, another $300-400 an hour, etc. so that by the time you finish the field investigations and the design you've spent more money than you would if you had built a wooden bridge. Anybody who has had anything to do with phasing the expenditure of large quantities of government funds can see the advantage of phasing bridge design and construction over the years. The Treasury Board usually prefers this. Another advantage of wooden bridges in the Northwest Territories is that the cold permits these bridges to last a lot longer than they do in the south. For example, on the Canol Road, some are still standing after 35 years.

A disadvantage of wooden bridges, is that they are more difficult to inspect and maintain than a culvert. The junction between the wooden bridge deck and the gravel road is a discontinuity which is awkward for grading. If you put in a culvert the graders can run up and down the road unimpeded. But in a wooden bridge, constant attention needs to be paid to the gravel next to the bridge. Cars and trucks scoop it out, push it down, compact it etc. So theres no question that its a problem for the foreman of maintenance. It is difficult to accurately assess the rating strength of a wooden bridge. Of course wooden bridges don't last as long as steel and concrete ones. Corregated pipes, can be put in quickly and cheaply. In spite of these disadvantages I think that wooden bridges should have been used on the Liard Highway. But engineering and maintenance people had their way and so there are none.

Discussion

BG They are building a wooden bridge on the Liard Highway, as a temporary crossing at mile 72.

RR Generally, the economics of wooden bridges are pretty hard to establish but I think they are good in the short as well as the long run. But first you have to prove it by putting some in. Wooden bridges can be temporary or permanent and they can be built on the alignment or off it. If they are temporary they should be built off the permanent alignment so a permanent bridge can be put in later without impeding traffic. The wood can be treated or untreated and you can get plans for all types. I suggest the very plain untreated, pile bent type with sawn decks and bracings. They can be produced in Fort Simpson or Wrigley or any other place that's nearby. Treating is very expensive and some types of wood are difficult to treat. Another objection of course is that the material used to treat wood is very toxic and to avoid impacts on fish it should be kept to an absolute minimum. Examples of wooden bridges are (a) the Territorial Government bridge in Fort Rae (b) along the Aleyeska Oil Pipeline, (c) British Columbia on the Stewart Cassiar Road. The provinces of British Columbia, New Brunswick and Quebec have policies and designs for wooden bridges and use them constantly.

I'd like to refer you to a report entitled "Examination of Alternate River Crossings for Northern Roads" by Damas and Smith. They studied the section from Wrigley up to Norman Wells. This is a good stretch because it's where the Mackenzie will be continued.

CK The economics of wooden bridges mixed with social, cultural and environmental problems can be very difficult to handle. How much design do you need before you construct a bridge like this?

RR When you're talking about initial access roads, there are differing opinions of how much information you need. But in this case there would be pretty simple measurements taken. If a bridge had been built before there would be some information on file and of course the bridge is of standard size. You need information on the characteristics of the stream bottom and banks.

CK I was also interested in the embankment protection. How would somebody in the field determine easily how much they have to protect the embankment from scouring?

RR Well in a case like this you usually use wing walls, drive some piles in them and then put in planks to keep the bank back. If you want to be a little more sophisticated you put in rock armour beneath the bridge. I don't think that I'd spend a lot of time designing it.

CK I guess it all depends on the stream. If you have no conception of how active the stream is and where it tends to go you may end up with meanders around the bridge. These are the kinds of problems you have to have in the back of your mind when you're trying to choose your site. All you may need is simply an air photograph or some observations to guide you.

RR You use air photographs if you're going to build it at a new crossing but at an old site the maintenance people have probably worked there for years and can tell you what's been happening, what the weak points are, what problems they've had etc. I would think they could give you enough information to make a design. But at a new site you'd certainly take more trouble than I've indicated here.

RB I'm wondering whether you can think of a strategy to persuade decision makers on the economics of wooden bridges. Maybe if you got Damas and Smith to go to the provinces that use wooden bridges and say "if it works there, why don't we at least try it up here on a trial basis." Then from these trials you could get the information you needed to see whether it was worth it.

RR I'd definitely go to the provincial bridge departments and I think you'd get what you need from them. When the consultant is asked to look at designs and give an opinion he usually sticks to something safe. They'll probably stay away from wooden bridges. I was wondering whether Saskatchewan's Department of Highways has a standard design for wooden bridges in the north?

DW No, not really. In fact some of the old wooden bridges are taken out as the highways get better because they don't meet standard design. You also have to remember the high cost of labour.

The other idea that you talked about, defraying costs over the years is a good one. It may cost $25,000 a year maintenance to repair a particular section of road but that's not part of the capital expense of building it. There's not enough foresight to reduce that maintenance budget by taking appropriate, though perhaps more expensive measures during construction.

CS In the case of a CNR track twinning operation going through Jasper and Robson park the maintenance operation did a lot of damage, relative to that caused by the actual construction and operation of the line. I'd prefer to build a good road ensuring the integrity of the stream crossing structures etc., then maintain a sound environment from that point on.

A REVIEW OF ROAD RELATED WILDLIFE PROBLEMS AND THE ENVIRONMENTAL MANAGEMENT PROCESS IN THE NORTHWEST TERRITORIES

by

John Donihee and Dave A. Gray

1.0 INTRODUCTION

The history of road building in the Northwest Territories is not a long one. Considering the vast area of the N.W.T., the total area accessible by road is limited and is concentrated in the Mackenzie district.

The first road, later to become the Mackenzie Highway, was built from Grimshaw, Alberta to Hay River, N.W.T. in 1938/39 for military purposes. During the 1950's the "Roads to Resources" policy resulted in substantial extensions of the Mackenzie Highway.

Major roads in the N.W.T. include the Fort Smith Highway, the Pine Point Highway, the Liard Highway (completion expected in 1982), and the Mackenzie Highway. In 1972, construction was initiated to extend the Mackenzie Highway north to Tuktoyaktuk. This work was halted in 1977 due to changing development priorities in the Mackenzie Valley. The Dempster Highway which originated in Dawson City, Yukon and runs to Inuvik, N.W.T., was opened in 1980. Winter access roads are frequently constructed to support exploration and mining activities. The Gordon Lake winter road, for example, was initially developed during the winter of 1968/69, and has been used every winter, with the exception of one year, since 1975. The Rae Lakes winter road and the Discovery winter road provide access to Echo Bay Mine and Discovery Mine, respectively.

The construction of these roads spans several decades. Only since the 1970's have environmental impact reviews of major highway developments been required. The Federal Cabinet directive instituting the Environmental Assessment and Review Process (E.A.R.P.) was issued in 1973. Consequently, the major highway projects completed or near completion in the Northwest Territories were never subjected to a thorough and systematic E.A.R.P. review. While some environmental studies have been completed in an attempt to control or mitigate impacts of these highways, they must, in all fairness, be evaluated within this historical context.

Almost all studies of the effects of roads on wildlife suffer from a lack of predevelopment information on population abundance and distribution. Comparisons with information during and after construction are therefore difficult. Documentation of long-term effects, especially in quantitative terms, of linear facilities in northern Canada is virtually non-existent.

This paper is based on a literature review and on the experience of the Northwest Territories Wildlife Service with road development projects in the N.W.T. Our goals are to provide:

1. A brief review of the literature on road-related wildlife problems and concerns;
2. A discussion of impact reduction strategies, an indication of how they fit into the engineering design process and a review of some case histories;
3. Recommendations for a comprehensive approach to the problems identified above.

2.0 IMPACT OF ROAD DEVELOPMENT

Many known and potential impacts associated with road development have been identified. Road development results in impacts to both wildlife habitat and wildlife populations.

2.1 Habitat Loss

Freddy and Erickson (1975), in a study of the Selkirk Mountain caribou, and Bloomfield (1979), in a study of mountain caribou near Prince George, British Columbia, found that the populations in their respective areas consisted of small bands of animals occupying discontinuous habitats. Each band was therefore vulnerable to increased development. Damage to, or destruction of, limited wintering habitat would have seriously jeopardized the existence of any one band.

Fyfe and Kemper (1975) reported that a primary concern with pipeline development (in many cases accompanied by road construction) is the loss of raptor nest sites and available nesting habitat through modification of bluffs and rock cliffs by road-cuts. The destruction of suitable cliffs through road development could cause the loss of irreplaceable habitat. MacLeod (1979) alluded to this problem in a discussion of the potential impacts of the construction of the Dempster Highway through sections of the Ogilvie and Richardson Mountains.

Often the destruction of habitat is not limited to the area encompassed by the right-of-way. Ancillary developments such as quarries, camps, and staging areas can precipitate reductions in wildlife habitat as well. Donaldson and Fleck (1979) indicated the importance of gravel rich alluvial flats along the Liard River. These areas are excellent moose wintering habitat in a region where moose population levels are not naturally high. The destruction of these flats through road construction-related quarrying activities could have resulted in the loss of valuable permanent habitat. Harding and Naggy (1977) documented cases where grizzly bear dens on Richards Island, N.W.T. were partially destroyed by vehicular activity or totally destroyed by quarry operations.

In some cases, the impacts of road development on wildlife habitat may not be judged to be significant. For example, only a small fraction of barren-ground caribou habitat that is several thousand square kilometers in size is removed from production by a 70 m right-of-way. However, not all species have large areas of suitable habitat available to them. Road development in habitats that are critical to a species' survival, or small in size, and biogeographically isolated could result in local and/or regional extirpation of that population. Not all of a species' range is necessarily comprised of critical habitat; some portions of a habitat may in fact be expendable. But every effort should be made to identify and avoid critical habitats during road planning.

2.2 Road-Related Disturbance of Wildlife

The effects of disturbance on wildlife are perhaps some of the least understood and the most difficult to quantify of all the impacts associated with road development. Disturbance begins with the initial intrusion into wildlife habitat by survey crews and continues throughout the life of the development and beyond. Disturbance effects have been reviewed extensively by Geist (1975), Klein (1971, 1979a), MacKenzie (1976), Environment Canada (1979), Miller and Gunn (1979), Shank (1979), Sopuck et al. (1979), Jakimchuck (1980). It seems that disturbance research has identified more questions than answers at the present time.

Avoidance of habitat by wildlife around the right-of-way and abandonment resulting from the synergistic effects of ancillary developments is a commonly identified impact of road construction disturbance.

The results of recent studies by Roby (1978) and Cameron et al. (1980) indicate that caribou cows show greater avoidance to vehicular traffic than to the road associated with the Trans-Alaska Pipeline during post-calving periods. Klein (1979a) stated that caribou tend to adapt more readily to lower volumes of regularly spaced traffic.

In the absence of human disturbance, most ungulates do not appear to have a strong avoidance to well designed roads that permit easy crossing (Sopuck et al 1979).

Habitat or range abandonment may result because of a species' inability to tolerate or habituate to adverse stimuli or disturbance associated with the use of the road.

On the otherhand, Skoog (1968) reported that hunting pressure and vehicular traffic along the Richardson Highway in Alaska frustrated, but did not deter migrating caribou from crossing the corridor. It therefore appears that the type of caribou activity and the time of year affect the response to roads and associated disturbance.

In most cases, increased habituation or tolerance of wildlife to roadside corridors is not acceptable. Such habituation could potentially precipitate an increase in the number of vehicle/animal (eg. moose and bison) collisions. Conversely, it is important that disturbances to migrating wildlife (eg. hunting) be minimized to ensure uninterrupted movements.

Jackman (1973) and Hinman (1974) stated that a major problem resulting from transportation systems in the north will be the associated increase in all kinds of developments. Klein (1971a) documented cases where reindeer in the U.S.S.R. were prevented from using former habitat because of the construction of a road, a pipeline, and ancillary facilities.

Habituation by ungulates to a single right-of-way, given suitable design, may be possible but habituation to a series of roads running at various angles could serve to compound the barrier effect and reduce habitat to unusable chunks. This could be a cummulative effect of uncoordinated developments. We have no examples to give you in a northern context, but understand that research on this problem is presently underway in the Prudhoe Bay area, Alaska (K. Jingfors, Pers. Comm.).

Generally, we have little quantitative evidence about how roads affect wildlife behaviour and whether or not they affect productivity. The majority of studies to date suffer from a lack of predevelopment information on wildlife population distribution and abundance. Little is known about the long-term impacts of transportation corridors on movements, and size and structure changes in populations. Most importantly, we lack comprehensive techniques that would enable biologists to conduct such studies.

The GNWT Wildlife Service is now undertaking design research that will develop techniques to enable biologists to study the effects of various types of linear development on caribou behaviour and productivity.

2.3 Access and Hunting

Access resulting from road emplacement is undoubtedly the most serious and the best documented impact of new roads. Klein (1979b) reported that an indirect effect of the Alaska Oil Pipeline project will be that a large tract of wilderness north of the Yukon River will be accessible by an all-weather road. Wildlife along the haul road will be particularly susceptible to hunting pressure. Harding and Naggy (1977) stated that a major problem on Richards Island, N.W.T. will be that new all-weather roads would render grizzly bears more vulnerable to hunters who live in Inuvik and Tuktoyaktuk.

In northern Alberta, 80% of the hunter effort and 23% of the total moose harvest occurs within 1.6 km of access roads (Lynch 1973). Bergerud et al. (1968) found that the mean distance travelled from a road to shoot moose in Newfoundland was 0.58 km in 1960 and 0.92 km in 1961.

Previous significant declines in moose populations in accessible areas surrounding communities in the southwestern N.W.T. suggests that access created by increased road development, if unregulated, will result in significant declines of wildlife populations. Donaldson and Fleck (1979) were of the opinion that the greatest effect of the Liard Highway on moose populations would be the resultant increased hunting pressure. Secondary access roads, eg. winter roads, in the N.W.T. also serve to create serious problems of access to wildlife populations. The Gordon Lake winter road, for example, which runs from the Ingraham Trail east of Yellowknife to Camlaren Mine on Gordon Lake, has been used by hunters to harvest caribou from the Bathurst herd. In early 1980, an estimated 2,000 caribou were harvested by hunters who gained access to wintering areas by this road.

Illegal hunting of wildlife by construction crews can contribute to the overall decline of populations if permitted to occur unchecked. In northern British Columbia, for example, the illegal harvesting of mountain goats by railway construction workers caused population declines (D. Hatler, Pers. Comm.; cited by Donaldson and Fleck 1979). Bloomfield (1979) reported that the illegal hunting by highway construction crews contributed to the decline of mountain caribou in central British Columbia.

2.4 Problem Wildlife and Road Kills

Hinman (1974) reported that during the preconstruction stage of the Alaska oil pipeline project, human-wildlife confrontations were a serious problem. The improper disposal of edible garbage and the deliberate feeding of wildlife in construction camps can precipitate problem wildlife situations. Scavenging bears and foxes will readily habituate to human presence in camps, which often results in the destruction of the animals.

Road kills during the construction phase of road development are not well documented, but they undoubtedly occur. It is unlikely that significant numbers of wildlife are lost through construction vehicle/animal mishaps. However, if taken in the context of cummulative impacts, this form of mortality could potentially contribute to reductions in wildlife populations.

It is estimated that fewer than 10 moose are killed on N.W.T. roads annually (Environment Canada 1979), but with increasing development will come more traffic, which will undoubtedly result in increased traffic mishaps. Donaldson and Fleck (1979) suggest that moose-vehicle mishaps along the Liard Highway could become a problem, especially during the fall and winter months.

In British Columbia, approximately 75-100 moose are killed annually on the road between Frazer Lake and Prince Rupert (Environment Canada 1979). Johnson (1976) documented mountain caribou road kills in British Columbia. Grenier (1973) determined that 14% of a moose population frequenting habitat that was bisected by the Laurentides Highway in Quebec was killed annually through vehicle mishaps.

3.0 IMPACT REDUCTION STRATEGIES

Environmental impact reduction should be a goal during all stages of the design, construction and operation of a road. The selection of an optimal mix of measures to achieve engineering standards, economic efficiency and Environmental Protection is a complex planning and design problem requiring interdisciplinary and interagency cooperation.

Several classes of impact reduction measures exist. Spatial or location measures seek to avoid areas of environmental importance such as critical wildlife areas or unique landscape features. Avoidance of critical areas should be one of the first goals of the corridor identification and selection stages. Avoidance of areas such as wintering ranges, nesting and concentration areas, and calving and post-calving grounds is the best solution to minimizing impacts. Avoidance measures can also be applied during the right-of-way selection to minimize local impacts.

Temporal measures facilitate impact reduction by eliminating disturbance related to surveying, clearing, construction and operation during critical periods in the life cycles of wildlife populations. Such measures will minimize the short-term impacts of project construction.

Operational measures refer to those codes of good practice, general rehabilitation and to the controls on employees which, if carefully adhered to, can reduce the overall impact of any project.

3.1 Impact Reduction and Project Planning

The environmental review process required for major projects in the north has several major goals. The identification and mitigation of impacts is one. Mitigation as a process encompasses those measures applied during the planning and design, construction and operation of a project with the specific objective of avoiding or reducing adverse environmental impacts. Mitigation is, however, only one component of the ongoing environmental management process which accompanies all development.

There are obviously costs involved with mitigation measures. Despite best efforts, all impacts cannot be mitigated; certain residual impacts or costs will always result from development projects. Within the overall cost/benefit analysis, the wildlife manager must accept certain residual costs with full knowledge that the more general benefits to society resulting from improved transportation sometimes outweigh residual impacts on environmental resources.

The essential point in such tradeoffs is that the environmental review process makes them explicit and that careful study of environmental resources such as wildlife and fisheries must precede any final decisions on their management.

As we have mentioned, mitigation is an expensive process. The more so when mitigation efforts are merely band-aids which we hope will alleviate the effects of insufficient or poorly timed environmental information imputs to the development planning process.

A recent paper entitled "The Impact of Environmental Assessment on Energy Project Development" (Loucks et al. 1980) examined the effect of ignoring or poorly studying environmental concerns during design and early construction phases of projects ranging from the Trans-Alaska Pipeline to the Garrison Diversion to the Great Canadian Oil Sands tailings ponds and dykes.

Estimated excessive costs resulting from poor environmental planning in these examples were $800 million, $400 million and $45-$90 million, respectively. No such analyses are possible for northern highways. Most were completed before the rise of environmental awareness and concern in the mid-1970's. Nevertheless, the central point should not be lost. The results of ignoring the need for careful study and analysis of environmental factors can be very expensive delays and design changes.

This message, of course, has not been lost on the road designers of today. Environmental codes of practice, guidelines, terms and conditions abound. Some problems do exist on the ground when these guidelines are implemented. Responsibility for enforcement, interpretation of intent, authority to stop construction or require design changes in the field all become troublesome considerations when the bulldozers are moving. In this respect, the need for careful integration of government agencies, contractors and developers is obvious.

In earlier discussion, we referred to gaps in information and a lack of techniques for studying impacts of road development on wildlife in the long term. Against this background, we have critically examined the mitigation process, set within the general context of northern road development.

3.2 Road Development - Some Examples from our Experience

Codes of good practice and many operational measures which mitigate environmental impacts can be developed and applied through common sense. Many of the long term questions about wildlife and roads will require in-depth study.

The information required to facilitate sound corridor planning and road design must be identified early and used to guide design and planning efforts during the pre-construction phases. Experience with roads in the north suggests that to attempt to resolve wildlife problems during the later stages of development often forces biologists to deal with the symptoms rather than the causes of impacts.

Examples of this kind have occurred in the Yukon and N.W.T. Studies are ongoing along the Dempster Highway in an attempt to quantify behavioual and distributional changes resulting from corridor development. However, pre-construction studies were not comprehensive enough to facilitate comparative analyses.

Winter roads also create wildlife management problems. Even though such roads may be used year after year, little detailed review and study accompanies their planning and development. We mentioned earlier the access problems created by the

Gordon Lake road. More significant concerns exist for the Cadillac Mine road being constructed from the Liard River to Prairie Creek; a distance of 160 km through several areas of Dall sheep and mountain caribou habitat and moose wintering areas. This road was approved under a land use permit with virtually no pre-construction environmental study.

Attempt to solve management problems generated from increased access through winter road construction are being made by the N.W.T. Wildlife Service. For example, during this past winter a plan to regulate access to and harvest of Bathurst caribou from the Gordon Lake winter road was developed. Our "Wildlife Ordinance" enables the N.W.T. Wildlife Service to establish special wildlife management areas in order to regulate access and opportunistic hunting.

Despite the lack of highway building in the N.W.T. of late, road-related problems will continue to crop up for secondary and winter roads.

We have been involved with an example of careful preparation for road development as well. When several major base metal deposits, and a consequent increase of exploration occurred in the Northeastern Mackenzie District in the late 1970's, D.I.A.N.D. and the G.N.W.T. Wildlife Service collaborated to fund a predevelopment survey of wildlife resources (see, "The Izok Lake Road Study"; Searing and Alliston 1979). This study outlined deficiencies in the wildlife information base and suggested necessary research plans. We are, in this case, prepared to respond with some foreknowledge to the potential problems a road development decision would present.

4.0 RECOMMENDATIONS

The road development process must include environmental information from its initiation. A lead time of up to 2-3 years may be necessary to complete wildlife inventory programs. The design process must be geared to incorporate environmental information during all stages of development, from concept to final design. A coordinated interdisciplinary approach is required to identify information gaps, establish research priorities and ensure communication among the various project specialists.

We must eliminate the concept of environmental assessment as a one-time predictor of impacts. Environmental assessment should be an ongoing process, thus enabling the merging of assessment with environmental management. This concept is a central component of Holling's (1980) call for adaptive environmental assessment and management.

Environmental reviews have not, for historical reasons, been a part of road planning in the N.W.T. Careful discussion amongst the agencies responsible and serious efforts should be directed at ensuring that new roads are planned to minimize losses to renewable resources.

4.2 Status of Wildlife Information and Techniques

The comprehensive reviews referred to earlier identify several common problems with respect to a wildlife manager's ability to contribute to the environmental assessment process. Wildlife scientists are playing catch up. Methods are not comparable between many of the existing studies, and basic gaps in the data base on wildlife species abundance, distribution, and critical areas exist for many areas studied. If engineers building roads were forced to work with as little information and impact prediction capability as wildlife managers, this country would be strewn with fallen bridges.

There is a need for selective studies to accompany road development from concept to operation and monitoring. We say selective because what we need to learn or to begin to study are the long-term effects of roads on wildlife. The root of this problem then, is the lack of techniques that enable statistically reliable, quantitative measures of behavioural and physiological reactions to linear disturbance.

These problems can and must be dealt with independent of one another. The N.W.T. Wildlife Service in cooperation with the Canadian Wildlife Service and Alaskan biologists have begun basic research designed to develop techniques to measure behavioural impacts.

Discussion

LH You mentioned that 2000 caribou were killed last year in the Yellowknife area due to road access.

JD Some of the problems that existed as a result of the access where things like people driving out with a native friend from Yellowknife and killing as many animals as they wanted under the GHL and just bringing them right back into town the same day. That of course would never occur if they had to take a skidoo and go out and camp to take their animals. There is a fairly sizable increase in the number of animals taken by sports hunters, people hunting under resident licenses in that area as well. Again, easy access I think is the main reason. In addition, people come from all around the lake, Hay River, Fort Smith etc. and hunt in that area and that obviously would never occur if there were no roads.

CS You mentioned that it took a minimum of 2-3 years to do wildlife inventories around new road areas. Is that correct?

JD Yes, assuming that the information that exists is poor or not available. For example, on the Cadillac Winter road there are no formal studies that would allow us to map out the winter areas for sheep in the Nahanni range through which the road crosses. We knew that there were sheep there, but that doesn't allow us to say, in a regulatory sense that there will be major problems. All we could say was that we think there are going to be some major problems and then try and get the proponent's consultants to do the work.

What happens is that the scale of information that exists in a lot of areas is regional in nature and cannot easily be used to assess impacts in a narrow corridor.

RR I wonder, if we're really using the information that we've got. It seems to me that no matter where you build a road in the NWT, the talent that we've assembled should be able to determine the kind of trouble it is going to create without doing any more studies. Right now we've got quite a few wildlife refuges, sanctuaries, IBP sites and so forth, which are effective.

JD I think that once agreement in principal is reached for the various land claim settlements we will then be in a position to sit down and to take a comprehensive look at the various areas that have been identified in the north as worthy of protection for one reason or another and to rationalize which ones really should be protected and then to move on them. As an example of the effect land claims are having, consider the Polar Bear Pass IBP review. The review process has just been extended one more time and I don't think that it will be an easy job to decide how to handle that area until the ITC's land claim is a little more clearly defined. Nevertheless, I agree with the arguments about existing information and I think it's very important for environmental managers to get away from the idea that as soon as there's an impact assessment required that you should run out and count everything and look under every rock to see if there isn't something there that you should protect. A lot of money that's allocated to the impact assessment process goes into the inventory phases that may not really result in the ability to make a decision as to whether the development ought to go ahead. We should use existing information and we should be very selective in the impact assessment process, to ensure that the money spent is actually going to improve our ability to make a decision about resource road projects. You've got to have a planned approach to resource development to make the best use of existing information. It doesn't do us any good to do an impact assessment of a highway one year, if they're going to turn around and decide that the highway will not go exactly where they first intended or they plan to run some spur roads off of it.

RR Planning is needed, but you also have to be able to control hunting and that doesn't seem to be happening.

LH I'd like to ask one question about the Cadillac mine road. Can you describe for us the regulatory regime or tell us why you didn't have enough environmental information before approval was given for the road.

JD The land use application was made in early spring in 1980. The consultants met with the Environmental Review Committee here and the various members identified their concerns. We met with them subsequently and indicated that we really didn't have a lot of information in the area and that, hopefully the approval of the road would depend on them providing us with that information. They were to prepare an EARP Initial Environmental Evaluation (IEE) and so we indicated the kinds of wildlife information we'd want to see. In actual fact the IEE was developed fairly quickly because they had to undertake construction during the summer for the first 20 or 30 miles of the road through the high country east of Prairie Creek. Because of that there was some pressure to get through the process quickly and to the best of my knowledge the environmental consultants spent only 3 or 4 days actually looking at the area by helicopter. There was a fisheries biologist, a wildlife biologist and a geotechnical specialist. Later they wrote a report which examined the available literature and identified the kinds of impacts they thought would result. The unfortunate thing was, a lot of the literature wasn't directly applicable to the site. Consequently we weren't too happy with the results. Several other departments on the environmental review committee were equally concerned but it was ultimately a DIAND decision and DIAND decided to approve the project.

PG Departments are continually reacting to emergencies. The Cadillac ore body and many others like it have been known for years and its a foregone conclusion that they're going to be developed sooner or later and they're a little remiss in not getting the information that is required long before hand. I was told by someone in Government that Norman Wells was dropped on them unexpectedly, but it's been around for 10 years. It's a known fact, that sooner or later there is going to be a pipeline in the Mackenzie Valley. And I would say it is the same with Cadillac, Izok Lake and Salmita etc. It's a foregone conclusion that they are going to come into production sometime. We should be doing something ahead of time, not always reacting after the fact.

JD That's true. Salmita's a good example as is Cullaton Lake and Contwoyto Lake although at Contwoyto and Salmita we keep fairly close track of caribou. We have a fair amount of information and are able to react to those development applications better than Cadillac where we just haven't allocated that much time or resources, except for some grizzly bear studies. Cadillac was a situation where the management agency got caught flat footed. It's the classic accelerated base line situation. I don't know if we should share the cost of developing the information with the consultant or not.

You can never get a mining company to tell you ahead of time what they want to do, but once they know what they want to do, they want it approved yesterday. It's an area where the agencies involved have got to keep track of what's happening. We've also got to allocate our resources to make sure that we cover off resource development projects over the long term, rather than just reacting.

LH John, could you summarize for us the results, of the caribou studies on the Dempster highway?

JD Frank Miller, Ann Gunn and Art Martell from our office have been trying to assess the effects of the highway on winter caribou distribution. When they started they were looking at other things too, such as the elevation of the road bed above grade and how that affected caribou habitat use. This is the 3rd year of work. During the first 2 years there were insufficient caribou to give them sample sizes that were adequate to make any firm statements. I'm told that they've got lots of animals there this winter. The kind of study design we are intending to use along the Gordon Lake road is very similar to what they are doing on the Dempster Highway. They're trying to develop techniques for quantifying distributional differences and hope that at some point in time they can relate these differences to the present or absence of a road. I'm not familiar with the results.

PG They are looking at density, group size, and composition, etc. along the Gordon Lake winter road. They're setting up control blocks and exposed blocks and relating these to distribution.

LC I know it's always quite easy to critize environmental assessments and impact statements. One of the big contributing problems is that people do not understand at what level of detail the studies are meant to be done. For instance, with Cadillac Mines, who understood the level the study was supposed to be done at? I'm sure the consultant has one opinion and the company has an opinion. Hopefully they are in agreement as to what information they should gather, but the assessment agencies might have totally different opinions. I'd like to see a standardization of terms so we know at what level we're studying.

Another point on wildlife management - I think that until wildlife agencies can come to grips with the problem of general hunting licenses, people being allowed to shoot 5 caribou etc., you're going to be beating around the bush talking about road access types. Access, in fact, is a symptom of the real problem which is simply the fact that people can shoot too many animals.

DW In Saskatchewan, when environmental impact assessments are produced the terms of reference are developed through the Department of the Environment in conjunction with each member of the Panel. We have representatives from difference groups on the Panel to look at the proposals, to look at what the consultant and the proponent intends to do, and to ensure that the terms of reference that have been developed for that study meet the objectives of each and every group. You have to develop impact assessment guidelines together. You can't do it in isolation because invariably what you're doing, is seeing the problems from different perspectives.

RB What type of organization would you have in Saskatchewan to bring the developer into the same room as the resource managers to produce these guidelines?

DW We have the Department of the Environment and they have an Environmental Assessment Secretariat to handle northern developments. The proposals are sent out to all representatives that sit on the panel of the Environmental Assessment Secretariat. We make comments on them and send them back. They send out the studies later on and we make comments on them and send them back. But quite often between the time we review the proposal and the final impact assessment statement we get an opportunity to look at terms of reference and sit down with the companies and say, look, we know there are grayling in this area. We can point out certain types of studies we would like to see. We may also be able to say, before you go any farther we want to know how you are going to put that crossing structure in and the time frame. We can work together with him on that, step by step as the project develops. I'm not saying we don't have problems but it's better than the way it was. The other problem is that we should perhaps be doing the studies ourselves. But because the development's going so fast, we don't have the staff, the budgets, so it's up to the proponent. If he wants to take billions of dollars worth of uranium out or if he wants to build an access road he's going to have to spend money to show the people and the government that he's going to protect the environment.

WALLEYE SPAWNING AND ROAD CONSTRUCTION
HIGHWAY CREEK, LA RONGE

by

M.Y. Chen

EXECUTIVE SUMMARY

SITUATION

Walleye entering the Potato River system were the largest known spawning stock in Lac la Ronge. In the early 1950s Highway Creek, the largest tributary stream in the system, accommodated as many as 30,000 individuals per spawning season. However, trap-netting of the run for three consecutive years, 1977-1979, has shown that this creek is no longer being utilized for spawning purposes. Numerous roads and highways within the Highway Creek drainage basin are believed to have resulted in lack of spring freshet, which is essential to the stimulation of a spawning run.

RESULTS

The terrain of the Highway Creek drainage basin is characterized by a relatively impermeable glacial till underlain by a layer of shallow (0.2-1.0 m), highly permeable sand and organic mat. Under natural conditions, most of the snowmelt water is transmitted to the creek as subsurface flow in the sand layer. In the last two decades, two major highways, numerous logging roads, and other access routes have been constructed across the predominant direction of water movement in the drainage area.

Soil moisture content and water table levels were monitored at various slope positions (surface to till) with a neutron scaler. Results indicated blockage of flow above the two main highways. This is due to the compact road beds built on the till which interrupts the continuity of the subsurface transmission layer and alters the natural drainage system. Visual evidence of severe impoundment includes revegetation of marsh plants, extensive drowning of forest and perpetual ponding along the road ditch in many locations.

Culverts placed in the road beds are non-functional in transmitting subsurface flow until the water table has reached the surface. The net effect is the introduction of a time-delay factor in the drainage system resulting in a greatly reduced spring flow during the critical spawning season and a general damping of the spring melt hydrograph.

A great majority of culvert stream crossings within the basin also impede or prevent upstream migration of fish. Three major problems associated with these crossings are elevated outlets, excessive water velocities in and around the culverts, and debris accumulation--sedimentation at the inlets.

The present study indicates a need for a more comprehensive environmental assessment of road construction and related development, such as forest harvesting, on the aquatic ecology and drainage hydrology. Measures to restore the spawning run of Highway Creek and to mitigate future problems of similar nature include:

1. Provision of drainage in the road bed on terrain susceptible to this problem.
2. Thorough investigation of drainage hydrology and pre-planning of the environmental aspects of highway construction.

Discussion

MC Walleye spawning in Saskatchewan is between the first week of May and lasts until probably the first week of June. There are many examples of obstructions which make it difficult or impossible for walleye to either move upstream to their spawning areas or make a potential spawning area unsuitable.

One example is a temporary winter crossing, located about 1 kilometre upstream of the Highway Creek mouth. If there is any obstruction to walleye movement it is probably the first one. I was told that the winter road had been there for about 10 years and abandoned some time ago, but nobody seems to have bothered with this obstruction. As a result, we've had a lot of logs falling downstream, causing obstructions to navigation, though not necessarily to fish migration. A few years later they decided to build a permanent bridge on top of this temporary river crossing. They built the bridge without doing anything about the logs or foundations. They also put the soil used in construction into the stream on top of the temporary winter crossing.

DW They did get most of it out but it would have been a lot easier if they'd had forethought.

MC I visited the birdge sometime in May and it was about 2 weeks prior to the normal spawning season for walleye. Along with the obstruction to fish migration we have this siltation problem. I was told the stream used to be 10 feet wide and now I would say is just 2 feet wide. That gives you an idea of the damage caused by road construction. I suspect that it was a major walleye spawning stream at one time.

DW They did do their best to get a lot of the sawdust and stringers out after a lot of cajoling and prodding.

MC There are other areas where they decided to remove the culvert without doing anything to prevent erosion.

DW What we have yet to do is convince people that what Maynard has done is correct, i.e. that these two highways are blocking subsurface drainage into the creek and preventing walleye from spawning. We're suggesting to them that there's got to be some way of getting this flow to go underneath subsurfically and they said they don't know of any way. And we thought, maybe we could at least do a test section, put in some sort of a drainage structure and see if we could increase the flow in this area. They said, why don't you go to the old highway, it's controlled by your own department, and since there's nobody using the road anyway, why don't you just get them to clear openings in it. It is a very sound idea which we will probably have to try. It would be really worth while if we can increase the water flow through these roads by removing some of these blockages. The next step would be to determine the engineering design to allow that subsurface drainage to go thru so that it won't be necessary to dig muskeg down to the bottom and put the road in or install culverts that freeze up in the winter. Is there any way of doing it? We had suggested maybe a fibre mat on top of the muskeg, with fill on top of that, but apparently it still compresses the muskeg and reduces the flow. What we really need are some innovative ideas from engineers.

RR There has certainly been a lot of headscratching over that problem and nobody's come up with anything very bright yet as far as I know. How to keep roads from squeezing off the cross flow is a real problem and I've read everything I could find on the subject. Nobody's ever come up with anything besides lots of culverts.

MC A culvert might be effective in the territories where you have surface overflow, but in Saskatchewan, you have this subsurface flow.

RR If I were you I'd show pictures of these problems to the nearest fish and game club I could find and get them good and mad.

MC In this study, we are not arguing that the total water budget has been reduced. All we are worried about is the time delay. Because of the highway's blockage we don't have this spring run peak and thats what we want to restore. I would say the effected area is about 15 miles but only about 4, 5 miles are critical in that you need some drainage mechanism.

RR I would say put in as many culverts in as you can.

RB I would agree with Rolley. I think you'd at least partially solve your subsurface water problem if you more adequately controlled your surface drainage.

DW The key thing here is that the water you saw on the surface is not originally surface flow, it is all underground. There's about a metre or more of permeable soil. It's a gradual slope and the water is flowing in that 4 feet of permeable soil. Underneath that it's an impermeable till and water won't go below it, so it flows through the sand on this gradual slope, until it hits the road which acts like a dike. Consequently, the other side is not getting water, except on a delayed basis. Maynard is saying that the road effectively stops that flow in the spring and acts as a dike. Sure it will flow along the ditch until it hits a culvert. I was at the Mitigation Symposium in Fort Collins and asked the Department of Engineers if anybody had even looked into it, and nobody had even thought of this type of thing.

RB Pipelines are not part of this workshop but I do understand that they have dealt with subsurface water flow when constructing pipeline trenches and have design techniques available to deal with this problem.

LH A number of ideas were presented to solve the problem on the Mackenzie Valley Pipeline but they were never tested.

BG We experienced a problem similar to this one in the mountains on the Cadillac Road except we were dealing with streams. We used large riprap at the bottom of the stream and put the road bed on top of it and it works. The stream flows thru the rocks, and the riprapp below, yet you maintain a good road surface.

LC I don't see why a culvert wouldn't work.

DW With a culvert you can't get the drainage back into the soil on the other side. One end is free and clear and the other end is plugged underneath the soil, at least it is if you want to get it subsurface again. On the other side there is no channel for the water.

LH But if you have a ditch on the upstream side and you have a ditch on the downstream side the water begins to pecolate through the soil so your time delay factor should be minimal, you should be able to get say 75% of your water through.

MC Your talking about a culvert every 2 or 3 metres.

DW One other problem is the freezing of culverts. We have to find some system to solve the whole problem of muskeg road building. I know you can put mats over muskeg and layers of sand but if that muskeg is compressed so the water won't flow, that's no good. So what we've got to do is find a way of getting the subsurface flow to go through. It will be a lot cheaper for construction and it will serve fisheries purposes as well.

CK Is there any way that the natural drainage system could be used to your advantage? On the map you showed quite a few tributaries running across the highway.

MC Those tributaries are in the upstream area. It is in the downstream section that you don't have enough water to stimulate walleye spawning.

CK Some of your pictures show that the spawning streams are blocked up quite badly. Some improvement would result from clearing up a lot of these streams.

MC What we are lacking is information on the significance of improper culvert installation in the upstream area. We also need information on the quantity of water that is blocked by the road.

CK On the other hand you can say "what kind of minimum flows do I need in the stream for fish to spawn?" Then work your way back from there.

DW But we don't know how much water we need to put back into the spawning stream and what it would take in order to do that. What we would like to do is take out part of the old highway in sections and have pizometer readings from both sides of the highway. If we were to do that and determine the new flow rate we might then be able to make some extrapolations across the whole highway to find out how much water we may be blocking. That would be something that would also benefit Maynards' study since it would show whether or not what he's saying is actually so. All factors point to it but this would just be an added fact.

CS Our company has done a number of jobs in which we have had to set up drainage systems and I think it's in your interest to check with some of our hydrologists and some of our water management people.

CK Yes a hydrologist would give you some good idea of what your options are.

REVIEW OF CULVERT FISH PASSAGE METHODS FOR FRESHWATER SPECIES

by

CHRISTOS KATOPODIS

Culverts can have a major impact upon the fish resources of a watershed by restricting, delaying or preventing their upstream migrations. Types and timing of migrations, swimming capabilities, fish passage requirements and design methods to meet them are reviewed.

Introduction

Important fish species in the Northwest Territories, Alberta, Saskatchewan and Manitoba (Table 1) utilize the myriad of streams in the region for spawning, rearing and feeding. Many of the streams are crossed by roads or highways and most of these are culverted. Improper culvert installations can impair or prevent fish migrations and thereby damage or even obliterate the fisheries resources of the watershed upstream of the crossing.

At a culvert, fish may encounter many impediments or complete blockages to their upstream travel. These may occur as fish attempt to enter, pass through or exit a culvert (Dane 1978; Dryden and Stein 1975; Lauman 1976; Metsker 1970: Watts 1974). Impediments or barriers to fish movement may result from:

a) construction activities,
b) physical blockages, or
c) excessive water velocities (Plate 1).

During stream crossing construction, fish habitat may suffer from siltation, pollution or loss of spawning, rearing and feeding areas (Plates 2-3). Fish may be physically blocked by:

a) An entrance jump beyond the biokinetic range of fish; the jump may be created by elevated outlets, either designed or scour induced due to excessive outflow velocities, or lack of a proper jumping pool at the culvert outlet.
b) A build-up of debris, ice, sediment and log or ice jams within the pipe barrel and particularly at the fish exit (i.e. culvert inlet) (Plate 4).
c) A shallow depth, during low flows, insufficient for submerged swimming of the larger fish.

PLATE 1 FROG CREEK, DEMPSTER HIGHWAY, EROSION DOWNSTREAM OF CULVERT CROSSING.

PLATE 2 LIARD HIGHWAY. SILTATION DURING CONSTRUCTION.

PLATE 3 CANEX PLACER ROAD. ROAD FILL WASHOUT.

PLATE 4 REDKNIFE RIVER, N.W.T. WINTER ICING CAN BE SEVERE.

TABLE 1 IMPORTANT MIGRATORY FRESHWATER[1] FISH OF THE NORTHWEST TERRITORIES, ALBERTA, SASKATCHEWAN AND MANITOBA[2]

Common Name	Scientific Name
Arctic charr	*Salvelinus alpinus*
Arctic cisco	*Coregonus autumnalis*
Arctic grayling	*Thymallus arcticus*
Broad whitefish	*Coregonus nasus*
Brook trout	*Salvelinus fontinalis*
Brown trout	*Salmo trutta*
Burbot	*Lota lota*
Chum salmon	*Oncorhynchus keta*
Dolly Varden	*Salvelinus malma*
Goldeye	*Hiodon alosoides*
Inconnu	*Stenodus leucichthys*
Lake trout	*Salvelinus namaycush*
Lake whitefish	*Coregonus clupeaformis*
Least cisco	*Coregonus sardinella*
Longnose sucker	*Catostomus catostomus*
Mountain whitefish	*Prosopium williamsoni*
Northern pike	*Esox lucius*
Rainbow trout	*Salmo gairdneri*
Sauger	*Stizostedion canadense*
Walleye	*Stizostedion vitreum*
White sucker	*Catostomus commersoni*

[1] Some are anadromous also, e.g. Arctic cisco, Brook trout, Inconnu.

[2] Nomenclature from McPhail and Lindsey (1970)

High water velocities, overtaxing the biokinetic potential of fish moving through culverts, may result from:

a) A steep longitudinal culvert slope.

b) An extended culvert length, causing overlong fish transit times.

c) An abrupt drawdown of the water surface, particularly at entrance and exit (Plates 5-8).

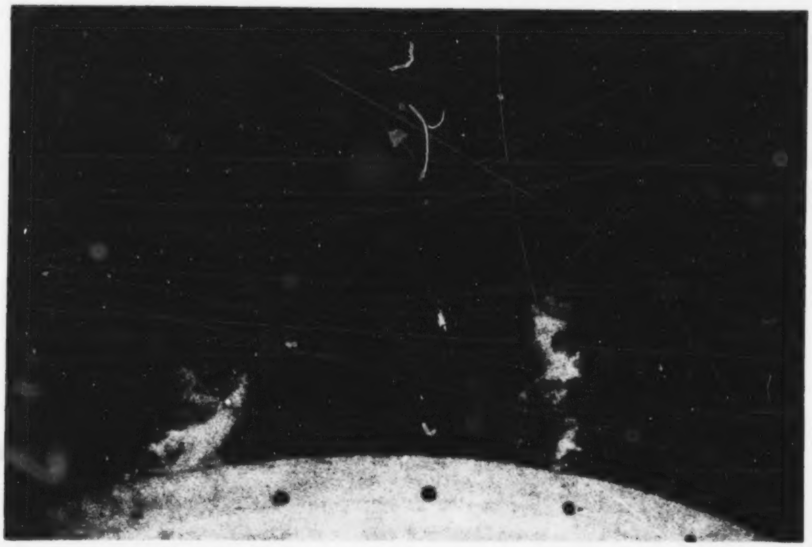


PLATE 5 SALINE CREEK, ALBERTA. HIGH INLET VELOCITIES MAY PREVENT FISH FROM EXITING THE CULVERT.

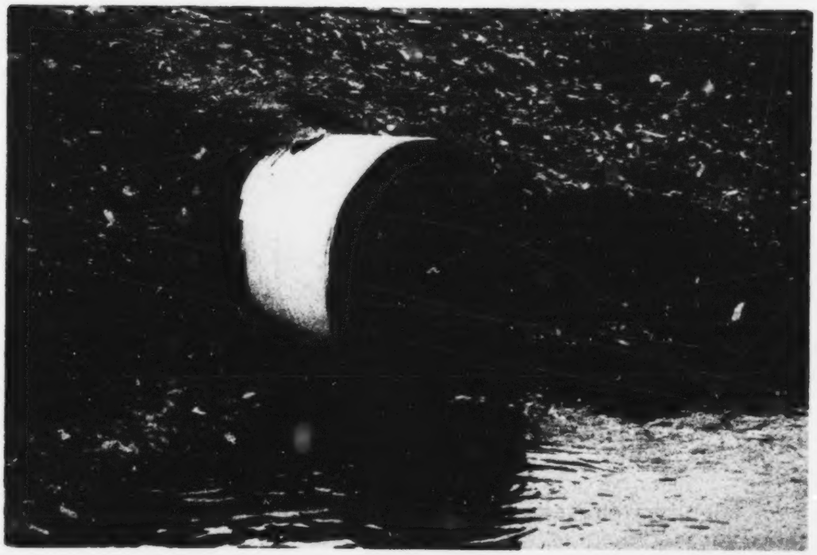


PLATE 6 MACKENZIE HIGHWAY NEAR INUVIK. ELEVATED OUTLET AND INSUFFICIENT WATER DEPTH IN CULVERT IMPEDE FISH PASSAGE.

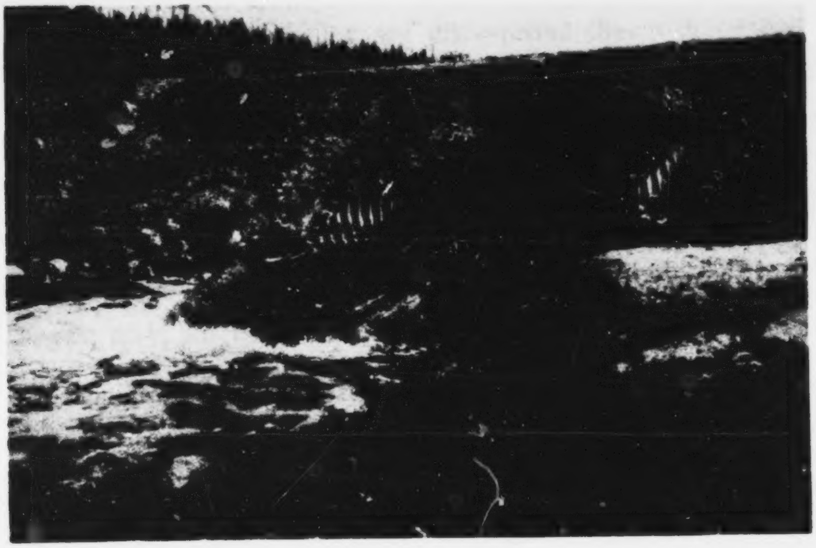


PLATE 7 MISTIK CREEK, MANITOBA. WATER DROP OUT AT THE OUTLET MAY BLOCK FISH MOVEMENTS.

PLATE 8 POPLAR RIVER, MACKENZIE HIGHWAY. HIGH OUTLET VELOCITIES MAY PREVENT FISH FROM ENTERING THE CULVERT.

d) A channelization above or below the crossing, requiring a longer swimming effort by fish.

e) A reduction in natural channel roughness and culvert undersizing.

f) A partial blockage by debris (generating excessive jet velocities).

Design methods to protect the fisheries resource when culverts are used are reviewed.

Biophysical Considerations

Fish Migrations

The most important fish migration is the spawning run. This occurs when mature fish return to the area they were spawned to deposit their eggs. Some species spawn in the spring, others in the fall. Spawning periods may vary annually depending on break-up and freeze-up dates, stream flows and water temperatures. Some spring spawners, such as arctic grayling, may start migrating even prior to ice break-up.

Timing is very important for spawners. Delays in migrations or spawning may result in either resorption of the gametes or spawning in suboptimal habitat with adverse effects on the spawners and the survival of the fry. Denial of the upstream spawning migration for periods of even three days could encourage reproduction in suboptimal habitat (M.M. Dillon Ltd. 1979).

The relationship between culvert design discharge and timing of the spawning migration may be elucidated by defining the "fish migration discharge", as the maximum discharge allowing a particular species to traverse the culvert. The fish migration discharge then would be a fraction of the design discharge for the fall spawners, but could be even equal to the design discharge for spring spawners, if the time of migration and peak flow coincide. This is practically the case in many streams that support arctic grayling and northern pike.

Fish also migrate to seek food, overwintering areas or favourable habitat. Passage for non-spawners is necessary for yearlings through to mature fish. Delays do not subject these fish to the same stress as the spawners and extended delay periods can be tolerated. However, fish passage is required during low flow periods which, at times, may be the governing criterion in culvert design, rather than spawner passage at high flows (Watts 1974).

Swimming Performance

Three biokinetic levels of swimming are distinguised (Beamish 1978; Webb 1975). They are defined by the time interval a given speed can be maintained by fish. *Sustained speeds* are those that can be maintained longer than 200 min and do not result in muscular fatigue. Sustained speed has also been referred to as "cruising speed" by Bell (1973), Dane (1978) and Watts (1974). *Burst speeds* represent the highest speeds of which fish are capable and are maintained for very short durations of up to 15 s. *Prolonged speeds* cover the spectrum between burst and sustained speeds and terminate in fatigue. This intermediate biokinetic level has been termed "sustained speed" by Bell (1973) and Watts (1974) and "sustained or prolonged speed" by Dane (1978).

The *critical swimming speed*, determined experimentally, is a special category of the prolonged speed. It is measured in swimming performance chambers by exposing fish to water velocity increments at regular time intervals, until the fish fatigues. The critical swimming spec, u_c, is then calculated by:

(1) $$u_c = u_i + \frac{\tau}{T} \Delta \upsilon$$

where u_i = the maximum velocity maintained for a prescribed period T

$\Delta \upsilon$ = the water velocity increment

τ = the time fish swam at the fatigue velocity

T = the prescribed time interval of swimming

Similarly, time to fatigue has been measured, keeping the water velocity constant and encouraging fish to swim continuously until exhausted. Generally, curvilinear relationships have been found between swimming speed (u), and fish length (l), as well as between swimming speed and time to fatigue (t):

(2) $$\ln u = A + B \ln l$$

(3) $$\ln u = C + D \ln t$$

These relationships are illustrated in Fig. 1 and 2, respectively. Equations (2) and (3) lead to the estimation of the maximum distance a fish can travel against a given water velocity. Such a distance provides a meaningful constraint in culvert design. For instance, in the case of a plain pipe, the maximum swimming distance may be interpreted as the maximum culvert length fish would be expected to traverse before fatiguing.

Fatigue curves for all three biokinetic levels are available only for rainbow trout, arctic char and sockeye salmon. Utilizing the critical swimming speeds determined by Jones et al. (1974) and assuming that the pattern of the fatigue curve for arctic char approximates that of other species, Dr. F.W.H. Beamish plotted curves of maximum swimming distance versus water velocity. Curves for arctic grayling, humpback whitefish, northern pike and walleye were determined. The curves correspond to the estimated shortest and longest mature individuals. It should be emphasized that the curves predict the maximum attainable distance by continuous swimming at a constant speed and with the opposing water velocity constant over the entire path that the fish follows.

Besides fish length, swimming performance is affected by other biological factors, such as weight, condition, sex, sexual maturity, injury and disease, as well as a number of environmental factors, including temperature and water chemistry. Fish length and water temperature though, are generally acknowledged as the most important parameters (M.M. Dillon Ltd. 1979).

Hydraulic Considerations

Fish Passage Requirements

In culvert stream crossing design, hydraulic efficiency and optimum fish passage conditions are mutually exclusive objectives. Compromises must be effected that permit adequate fish protection with maximum economy. Since not all parameters are readily quantifiable to the same degree, the designer should not only have an appreciation of the factors involved but choose design criteria judiciously.

In nature, stream morphology is in continuous hydrodynamic interaction with the water and sediment discharge. This interaction shapes the stream into a dynamic and idiomorphic ecosystem frequently suitable as fish habitat. The morphological features, so essential in determining stream mechanics, are also important components of fish habitat. Among other things, they generate a variable, heterogeneous and a symmetric water velocity field throughout the stream length and width, that allows fish to migrate in a variety of water flows. In contrast to this idiosyncratic morphology and hydraulics of the natural stream, culverts present constant and unyielding morphology and, often, almost uniform hydraulics throughout their length. As a result, fish migration through culverts becomes a difficult or even impossible task unless culvert hydraulics and fish biokinetics are matched.

The fish species and their migration patterns, in conjunction with the hydrology of the stream, can provide an estimate of the fish migration discharge. For this discharge curves have been developed which provide estimates of limiting mean water velocities through culverts for arctic grayling, humpback whitefish, walleye and northern pike of varying lengths. It is essential however that during low flows, the minimum culvert depth be sufficient to submerge the largest passing fish. From the recommendations of Dane (1978), Dryden and Stein (1975) and Metsker (1970), a minimum depth of 200-250 mm is considered adequate (M.M. Dillon Ltd. 1979).

Other considerations in designing culverts for fish passage include:

a) placing culvert inverts below stream bed elevation;
b) avoiding concentrated water drops, particularly at the inlet and outlet;
c) reducing the culvert length to the minimum possible;
d) scheduling construction activities so they do not interfere with the spawning migrations or incubation periods and avoid deleterious effects on fish habitat;
e) minimizing hydraulic losses and the possibility of debris or ice jam blockages;
f) protecting against erosion;
g) investigating the possibility of selecting an economic bridge for the site.

Design of Plain Culverts

In plain culverts water velocities are nearly uniform and fish are forced to traverse the entire pipe length by continuous swimming. Even the largest walleye, the best performer of the four species considered, could not be expected to advance more than approximately 20 m against a water velocity of 1 m/s. Designing a plain culvert with a mean water velocity of less than 1 m/s at the fish migration discharge is not practically or economically feasible in most cases. This is particularly true for spring spawners and long culverts.

In a number of sites, water velocities can be reduced by counter sinking the culvert a minimum of 300 mm and installing tailwater controls 5 to 7 pipe diameters from the outlet (Dane 1978; Metsker 1970; Watts 1974). Backflooding is accomplished by constructing a concrete or wooden box or a weir downstream of the culvert outlet (Plate 9). A weir built of rock or gabions is usually the most practical alternative. The weir is notched to ensure sufficient water depth at low flows. The hydraulic head on the control structure should not exceed 200 mm for most freshwater fish. Otherwise the tailwater control may itself become a barrier. Where larger head drops need to be accommodated, an appropriate number of controls should be built.

PLATE 9 HANGINGSTONE RIVER, ALBERTA. DOWNSTREAM WEIRS CAN BE USED TO ELIMINATE PROBLEMS ASSOCIATED WITH ELEVATED OUTLETS. ENSURING THAT THE WEIRS ARE PASSABLE BY FISH IS ESSENTIAL.

Design of Baffles

Baffle installation within a culvert enhances fish passage considerably (Dane 1978; McClellan 1970). Baffles are blocks, plates or sills methodically arranged and attached to the culvert floor. They provide resting zones at regular intervals and require continuous swimming only for the distance between such resting areas. Fish then, may use their burst speeds to advance through the culvert in stages. In this mode of navigation, the largest walleye can now travel 2 m against water velocities of approximately 1.65 m/s. This advantage over the plain culvert leads to culverts of smaller size and steeper slope.

The hydraulics of at least two baffle arrangements, shown in Plates 10 and 11, have been studied in model and prototype and can be predicted. Katopodis et al. (1978) provide details of these studies and a method of judging baffle adequacy; they recommend a minimum baffle height of 300 mm and a limiting culvert slope of 5%. Engel (1974) recommends a minimum diameter or rise of 2.5 m, when baffles are employed in circular or elliptical culverts.

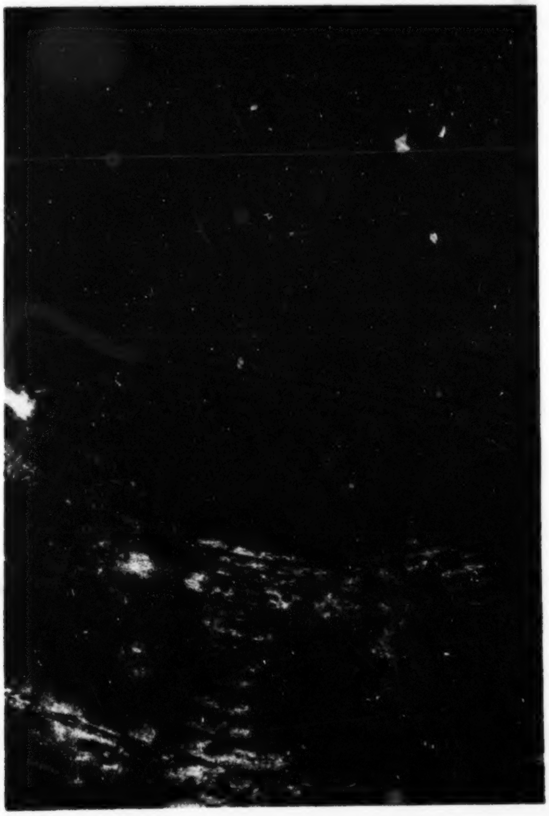
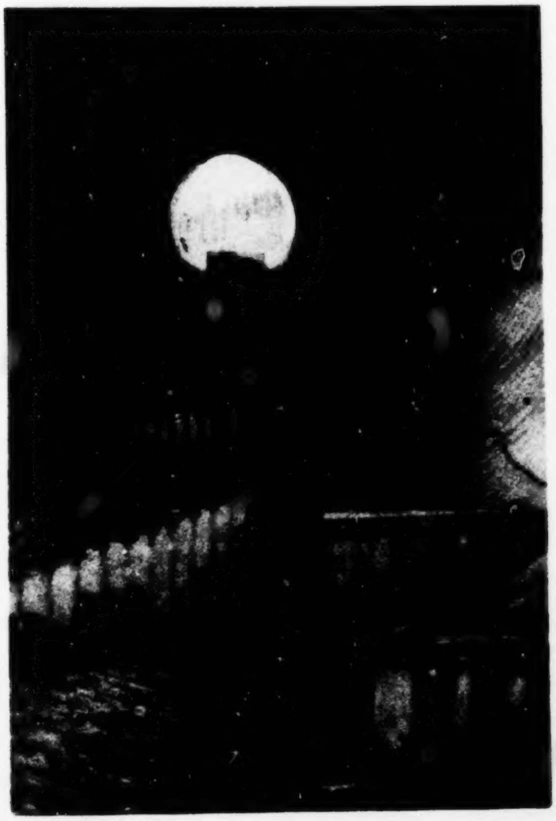


PLATE 10
REDKNIFE RIVER, N.W.T. SPOILER BAFFLES CAN ASSIST FISH PASSAGE.

PLATE 11
REDKNIFE RIVER, N.W.T. OFFSET BAFFLES CAN ASSIST FISH PASSAGE.



Baffles are usually constructed out of wood, concrete or metal. Most debris that may accumulate in low velocity areas created by the installation of baffles are flushed out of the culvert during high flows and baffle function is not normally impaired. This has been the experience in British Columbia and in the States of California, Oregon and Washington as reported by Dane (1978), Kay and Lewis (1970), McClellan (1970), McKinley and Webb (1956) and Webb (1968). McClellan (1970) inspected and documented the fish passage effectiveness of 66 culvert installations in Oregon, 13 of which utilized baffles. He concluded that:

a) debris appeared to collect as readily in pipes without baffles as in those with baffles, and;

b) contrary to common assumption, maintenance problems do not seem to be increased by the installation of fish passage facilities within the culverts.

Katopodis et al. (1978) report only minor problems with ice and debris in the case of the offset baffles. Although baffles have been used successfully in passing salmonids, experience with other fish species is lacking.

Culvert Fishways

Fishways are facilities that provide controlled hydraulic conditions which allow fish to pass upstream. Baffles can be considered a type of fishway. The principles of fishway design have been documented by Bell (1973), Clay (1961), Decker (1967) and Ziemer (1962) and could be applied to culvert installations. Watts (1974) adapted a vertical slot fishway and incorporated hydraulic characteristics reported by Dass (1970) and Harrison (1972). Field experience with culvert fishways is lacking and they are only recommended when all other options are unsatisfactory (Lauman 1976).

Stream Simulation

Bridges and arch culverts supported by footings allow the retention of natural stream properties at a crossing and do not normally hinder fish migration unless, of course, significant channel constriction occurs. One can then can conceptualize ways of simulating the stream properties and thereby minimize fish passage problems.

Stream simulation can be accomplished by approximating stream morphological features (Plates 12-13). In practice, a culvert of sufficient size to maintain average stream width and cross-sectional area at the fish migration discharge, is set at the average stream slope for the site, countersunk and filled to stream grade; the top

PLATE 12 LIARD HIGHWAY TRIBUTARY. NATURAL RAPIDS PASSABLE BY FISH. NATURE INDICATES THAT SIMULATING SIMILAR CONDITIONS WITHIN CULVERTS MAY ALLOW FISH TO PASS.

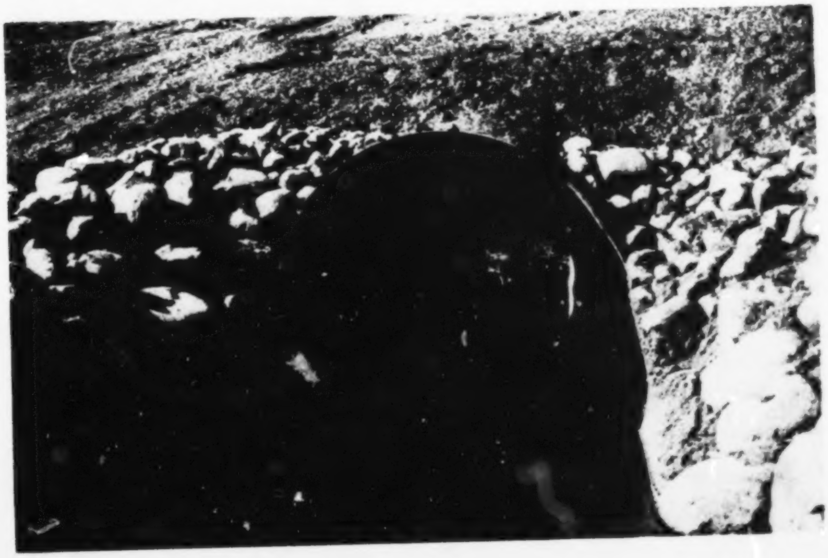


PLATE 13 MACKENZIE HIGHWAY. COUNTERSUNK CULVERT. HIGH POTENTIAL FOR FISH PASSAGE.

layer of the fill is non-uniformly laid rip-rap, stable for the design discharge and notched to concentrate low flows. It can easily be visualized though that undersized or long culverts depart notably from the natural conditions and approach the plain culvert situation.

The Department of Public Works of Canada accepted the stream simulation concept advanced by the author and found it more economic than the design of plain culverts, for fish passage. The Liard Highway stream-crossings with fish passage problems have been constructed according to the stream simulation technique (Plates 14-15). Evaluation of these culverts, planned for 1980-81, is expected to elucidate the technique further.

Conclusions

Fish passage requirements should be an integral part of stream crossing design. For the regional species, back flooding of plain culverts, installation of baffles or stream simulation would be necessary in the majority of cases. Structures that retain natural stream properties at the crossing, such as bridges and open arch culverts, should be investigated; they may provide a more economical alternative to culverts, particularly where large cross-sectional areas are needed to maintain acceptable water velocities.

Discussion

DW On baffled culverts, do you not run into problems if water is higher than the baffles?

CK The report on the Redknife River study (which is available) indicates that for a range of discharges and a corresponding range of depths, most of which were much higher than the baffles themselves, there usually are areas where the velocities are much lower than the mean water velocities and can allow fish passage. The higher you go above the baffle the higher the velocity is going to be but still at the bottom you'll have a substantial area where the velocities are low enough to allow fish to pass. If they swim at the surface they probably will not make it but if they swim close to the bottom of the culvert, chances are they will make it.

PLATE 14 LIARD HIGHWAY. COUNTERSUNK CULVERT WITH HEAVY RIP-RAP. WITH RIP-RAP THROUGHOUT THE CULVERT FISH PASSAGE SHOULD BE EXCELLENT.

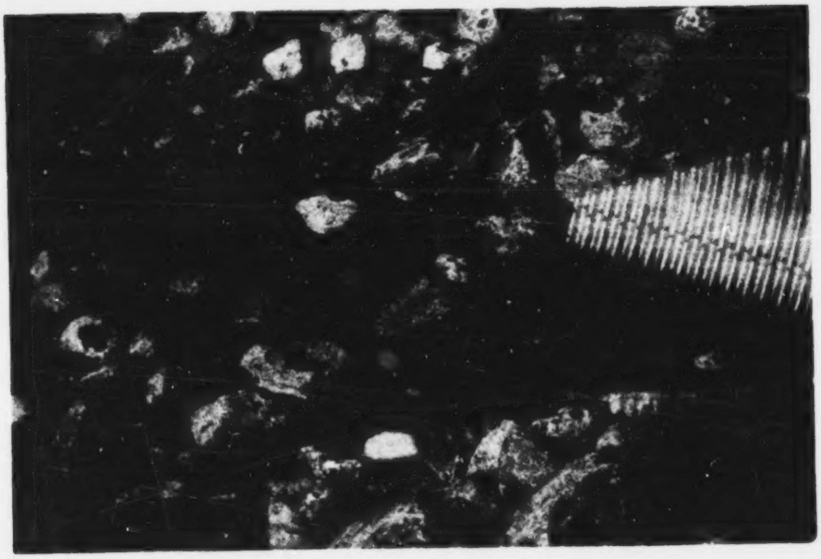


PLATE 15 LIARD HIGHWAY. RIP-RAP PROTECTION AGAINST SCOUR, DOWNSTREAM OF THE CULVERT.

DW What about the cost of a baffled culvert and problems with debris. An arch culvert would seem to me a lot cheaper to put in. For a culvert with baffles you have to have welders, time to put baffles in etc. Do you know of the cost effectiveness of baffles?

CK We have the costs for the set of baffles we used and they are in the report. Actually those costs were rather inflated because this was a prototype study. You also have the flexibility of using metal, concrete, timber etc. So availability of materials and the way you construct it will have a bearing on the cost. As far as debris and maintenance is concerned, we only studied the culverts for one year so we couldn't really predict long term problems with debris. In that one year we didn't have any problems. These baffles have been used in the West coast and the East coast quite extensively. If siltation occurs or stream bed materials get lodged between these baffles it doesn't necessarily eliminate their efficiency. They're still functional; they still provide resting areas for the fish although maybe smaller areas.

BG Have you had beaver problems?

CK The culverts have been there since '76. The problem is we haven't been observing them every year so if there are problems in that respect we are unaware of them.

LC With regards to rip-rapping in culverts, having been on the Liard highway for instance in the early spring prior to the freshet, I observed that all rip-rap was covered by ice. Given the fact that the ice in the culvert would not break up as quickly as ice in the streams, is it not possible that you could pass the highest flows when the rip-rap is not available for a resting place.

CK If in some instances water temperature is high enough and the fish are coming up before the ice has had a chance to move out of the culvert, you may run into that problem. The other problem you may run into is that the ice itself may take some of the rip-rap out. So you need a maintenance program when you use rip-rap.

RB Under some circumstances I understand that stream bottom materials, will over the course of time, go into culverts naturally if the inverts are below the stream bottom.

CK Some of it will move in and out naturally but it would depend on the stream you are dealing with and what substrate material you have. Obviously you cannot count on the fines. They will always move in and out very easily. But if large enough substrate exists that can be moved only once every major flood and eventually end up in the culvert then you may have the same effect but you'd have to have very large substrate in the stream and have to wait a number of years before it really lodges itself in the culvert. The other thing to remember is that the material that is coming in has a better chance of moving out of a culvert than an equivalent stretch of stream. You need some material to at least provide a back-up to stop the material from going out of the culvert.

CS How big were the fish that were tested?

CK On the Redknife River we had adult fish, anywhere above 200 millimetres in length. A lot of the information in the literature on fatigue times is for young fish, although some is for adults, especially arctic char.

AD I was involved with the research when they tested arctic char. The line across the top of your graph is a 10 minute fatigue time. To obtain that information they used a chamber that was about 40 cm in diameter. This was beside the stream. The fish they used were 40-50 cm long. You just put them in and accelerate the water then keep it at a certain velocity until they were tired. They used the same chamber to test different N.W.T. species.

MC I also used the Jones (Jones et al. 1974) approach to prepare culvert installation guidelines for construction workers. Is the 10 minute critical speed a good criterion or would a 5 or 7.5 minute speed be more suitable in constructing your curve?

CK I think thats an area where we need some more information. Really what we're doing is taking one point on a curve and extrapolating for the others, then convert the time versus speed curve into speed versus distance. We're only taking one point in the curve and drawing parallel lines from that point to the arctic char fatigue curve. That's how those other curves were derived. Now, it would be useful to have information on other species and on the variety of time intervals in order to describe those curves much more precisely. Those curves are only a guide. If you're using a plain culvert, you note the length and look up the allowable velocity you need for the species involved. If you're using baffles, then you'll note the distance between 2 baffles and look up the allowable velocity for the species involved.

EROSION PROBLEMS ASSOCIATED WITH NORTHERN ROAD CONSTRUCTION

by

Lorne Cooper

There are specific areas of the Liard Highway where ditch erosion is occurring in silty material. We inspected areas along the Mackenzie Highway north of Simpson with similar materials and found similar erosion. It seems clear that we're not getting revegetation in this type of area. The erosion only occurs on fairly steep slopes. We also noted that on the Liard Highway that the ditch block measures to control erosion were not usually adequate. They were either underdesigned or not constructed to design. Probably a little of both but the water washed right through them and in some cases took them right into the stream below. Some of the suggestions for stabilizing the areas were revegetating steeper slopes, larger ditch blocks, gravel aprons and brush. This is a slide (Plate 1) of the Liard Highway showing erosion at the sides of the road with a very steep bank nearby. Here's another (Plate 2) example of slope erosion. There doesn't appear to be any ditch blocks. Here's a good example (Plate 3) of a ditch block which disintegrated. They had a shortage of rip-rap and I think that contributed to under-constructing the ditch blocks. You can also see the resulting silt in the stream bed. Here's another example of ditch blocks (Plate 5) that haven't really served their purpose. Again, some more erosion. This slide shows more erosion, (Plate 4) and this shows ditch blocks that seem to be functioning quite well.

Discussion

LH When Sharon Hartwell and I inspected this road in 1978 those ditch blocks weren't there. There was a culvert under the road and one big ditch block to divert the drainage across to the upstream side of the Poplar River crossing. It was poorly designed and plugged. I see they've upgraded it and done a nice job. In the Northern part of Alberta, they

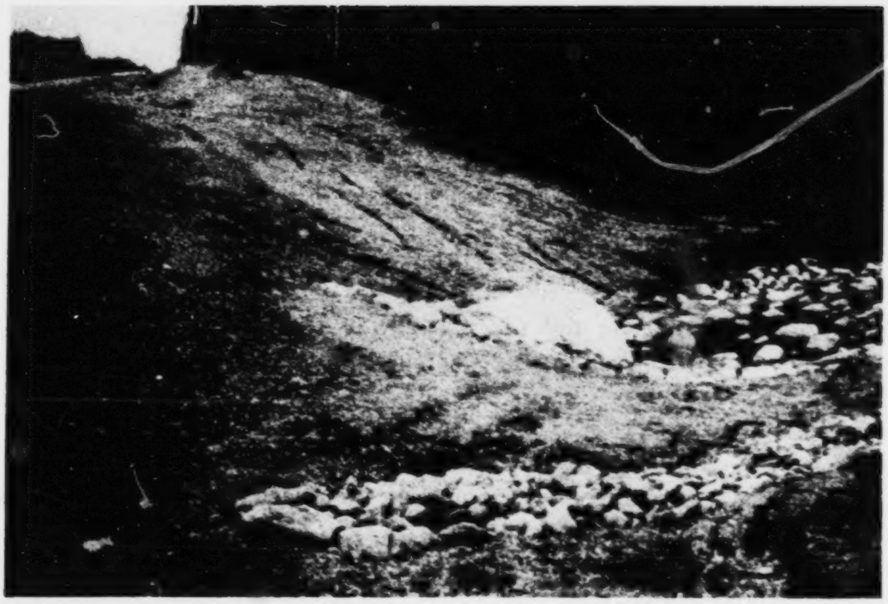


PLATE 1 ILLUSTRATION OF ROADSIDE AND DITCH EROSION ON THE LIARD HIGHWAY, N.W.T., SUMMER, 1980.

PLATE 2 AS FOR PLATE 1.

PLATE 3 AS FOR PLATE 1.

PLATE 4 AS FOR PLATE 1.

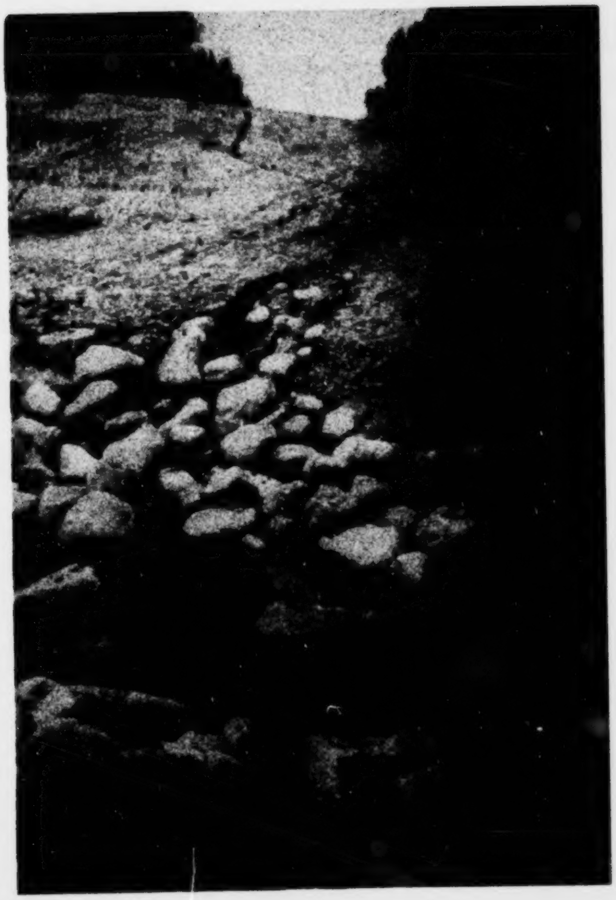


PLATE 5 AS FOR PLATE 1.

use bales of hay. They're cheap, easy enough to handle and from cursory observations, they seem to work quite well.

BG The sand bag method was used on the Mackenzie Highway and that accomplished the same purpose but it was more expensive. Rocks for ditch blocks cause problems, especially square rocks, because the water will undermine them.

LH If water is undermining the ditch blocks I suggest you use more ditch blocks more closely spaced to slow the water and let the sediment settle out.

BG You also need to put the ditch blocks slightly deeper into the soil.

RB Bernie Gauthier, DIAND (Yukon) suggested a combination of brush and rip-rap.

LC That might be a good solution when rip-rap is not available in large quantities.

DW One other possibility is to narrow the approach to the stream crossing during the summer and leave the land clearing around the stream until winter. In the spring the vegetation, at least in Saskatchewan, grows quickly because the topsoil hasn't been disturbed. This vegetation acts as a buffer around the streams and protects them. But this necessitates pre-planning to keep the approaches to the stream crossings narrow until such time as your ready to clear it for your work.

LC On the Dempster Highway they avoided the problem of taking fill from the ditches by using end dump construction.

DW In our guidelines, you can't take fill or raw materials within a certain distance of the stream. This prevents the removal of borrow material in such areas and it does help.

LC On the Howard's Pass Access Road, also known as the Canex Placer Road, eighty to ninety percent of the culverts wash out each winter. I would guess that the cause is icing. During the spring runoff those culverts are full of ice. In some cases they may also be underdesigned. Major washouts occurred from a rain fall in July 1979. There were very high flows in streams at that time. I recall suggesting in one inspection report that given the fact that the Howards Pass Access Road is only a temporary road, whenever possible culverts should not be put in. I recommend fording or snow bridges. In general, I question the wisdom of putting in culverts on temporary roads when they're not absolutely necessary.

I'd like to point out that although these culverts have washed out, the material is coarse and I don't believe it's creating erosion problems in the fish streams below. Lack of culvert maintenance is the main problem on the Howards Pass Access Road. They were frozen and the water came up and washed the road out beside and around them. It's hard to say, but I think water management agencies would have used fords if we hadn't been after them all the time to put in culverts. Its our own fault.

LH On the question of whether or not the culverts on the Howards Pass Access Road were underdesigned from a fish passage point of view, the following guideline was used: if the stream is at more than a 10% gradient then it probably doesn't contain fish, but if it's at less than a 10% gradient then, it's probably a fish stream. The Howards Pass Access Road was constructed, in a manner of speaking, to temporary road standards and now I understand from Lorne that it's to become a permanent all weather road. If that's the case then I feel there should be a considerable amount of upgrading.

RR As far as I know they never seriously contemplated bringing heavy loads, say of ore, out through that road. It was never designed for that.

CK One final comment on ditch blocks. The problem on the Liard Highway is that there is no readily available rip-rap that is large enough. One could use a smaller size and enclose it in wire gabions, however.

RR That technique is very expensive, but effective.

LC You can buy the wire, put the rocks in and make the gabions yourself. But on the steeper slopes I just can't see gabions being economical so it's certainly worth looking at brush; brush in conjunction with revegetation.

RB I've got a report by the U.S. Highway Administration prepared for the state of Alaska. They go into at least 10 different techniques for erosion and sediment control. It's entitled: Best Management Practices for Erosion and Sediment Control. Dept. of Transportation, Federal Highway Administration, Region 15. 1978.

WILDLIFE HABITAT ENHANCEMENT ALONG RESOURCE ROADS

by

Carl Surrendi

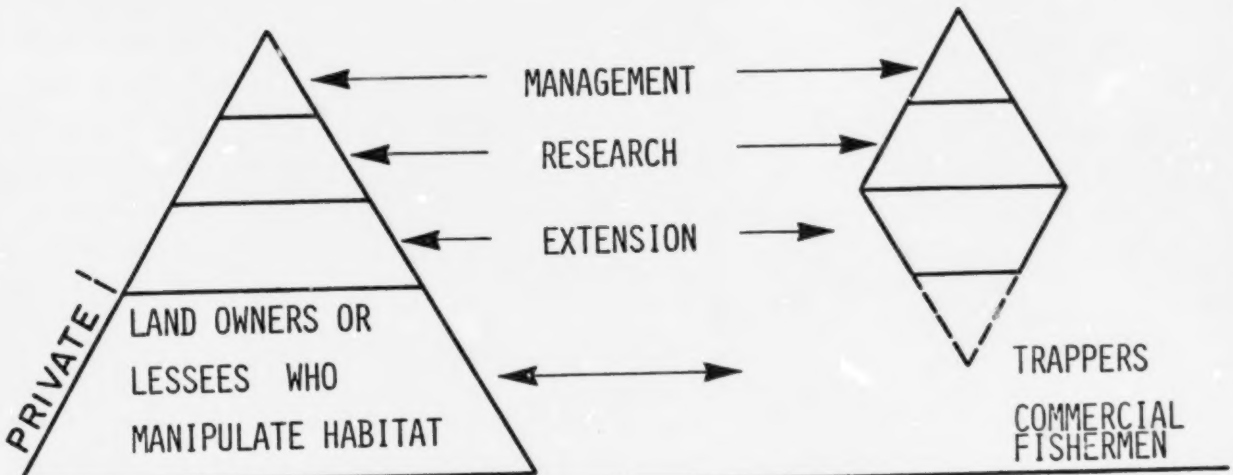
I will discuss a number of techniques not to just reclaim but to create habitat in certain areas. Comments will be confined mainly to linear facilities e.g. roads.

Climax ecosystems have rarely produced the kinds of wildlife or livestock species that mankind requires. To get what he wants, man tends to use ecosystems at sub-climax levels. For this reason I am therefore not always concerned when roads are built and land is being cleared because in a matter of time the disturbed areas will revegetate at a lower successional level and will provide both cover for the land and a new food supply for the wildlife species that are using the area. I'm not saying that this should be done everywhere. I would like to see a lot of the country left undisturbed.

I'm confused on occasion with the terms environmental damage and significant impact since they always imply something negative. But there are situations where impacts are positive because the environment has been changed to produce something that I have a preference for. The question of whether the change is positive or negative is always a subjective judgement. From the standpoint of the engineer who builds the road the change is positive. From the standpoint of the university professor who has worked in the Arctic for 30 years it may be a disaster. The question is, who's right?

There are some fundamental differences between wildlife agencies and their management schemes and other resource based industries such as Forestry, Agriculture and the Oil, Mining, Road and Railroad industries. One of the main differences is land tenure. Industries have a pyramid-shaped organization with senior management at the top level (Figure 1). Down below are people doing research. Below them there is generally an extension group who take the information that the research people produce, reduce it to something that the average citizen can understand and pass it on to managers, land owners, lessess etc. These people

FIGURE I



OIL INDUSTRY, AGRICULTURE FORESTRY, MINING	WILDLIFE
1. HABITAT MANAGEMENT GROUP VERY LARGE	1. HABITAT MANAGEMENT GROUP VERY SMALL, IF IT EXISTS AT ALL - GOVERNMENT
2. OWNS OR LEASES PRIVATE LAND	2. NO LAND TENURE
3. HABITAT MANAGEMENT GROUP - PRIVATE - MAKE THEIR LIVING FROM THE LAND THEY OWN OR LEASE - HENCE STRONG VESTED INTEREST AND POLITICAL POWER	3. VERY SMALL GROUP WITH VESTED INTEREST WHO MAKE THEIR ENTIRE LIVING FROM FISH AND WILDLIFE - NO POLITICAL POWER

utilize this information to enhance their enterprises. In the Agriculture, Forestry, Mining and Transportation organizations there is a habitat management group at the bottom which is very large. They own and manipulate their land or lease land to manipulate the surface. They make their living off land, which they own or lease and they have a very strong vested interest and a tremendous amount of political power.

Now let's look at wildlife and fisheries agencies. The top of the pyramid is the same, with management at the top figure 1. Underneath we have the research group and under that there is a limited extension capability-wardens and wildlife officers and in some cases extension biologists. Below that, things taper off to virtually nothing. We have the odd trapper who makes his living from trapping and we have a few fishermen who make some money. The habitat management group is small if it exists at all. There is almost no vested interest in the group, outside of an enjoyment of wildlife. There is no land tenure so there's no political power. It is in the habitat management area where wildlife habitat managers could achieve a great deal. It's not in the interest of the mining industry etc. to raise cows or grow trees but they may put the land back the way habitat managers want it. I think this fundamental change would make it much easier to work with the mining oil and transportation industries.

This slide was taken in Montana (Plate 1). It is a borrow pit that has turned into an extremely productive pond. It's loaded with turtles, reptiles, amphibians, ducks and muskrats. This slide (Plate 2) shows an old farmstead in the Suffield army reserve. It has about the only really good cover for a number of miles in any direction and is utilized by sharp-tailed grouse and both species of deer. So mankind accidentally creates a lot of good habitat.

This slide shows part of the Cold Lake Oil Sands project (Plate 3). You'll notice a large fen in the left of the slide. It is areas such as this that we are examining from the standpoint of habitat manipulation. We blasted some pot holes (Plates 4-5) along a winter road in this area to create ponds. We lost 2 out of the 5 potholes that we blasted because the hard sand substrate was too far below the peat mat surface but 3 of the ponds turned out (Plate 6).

PLATE 1 THIS BORROW PIT, LOCATED ON THE ROSEBUD MINE SITE IN COLSTRIP, MONTANA WAS CREATED AND ABANDONED WITH NO THOUGHT OF FUTURE USE IN MIND. NEVERTHELESS, THE POND IS HEAVILY USED BY TURTLES, OTHER AMPHIBIANS AND REPTILES, WATERFOWL AND NUMEROUS SMALL BIRDS AND MAMMALS.

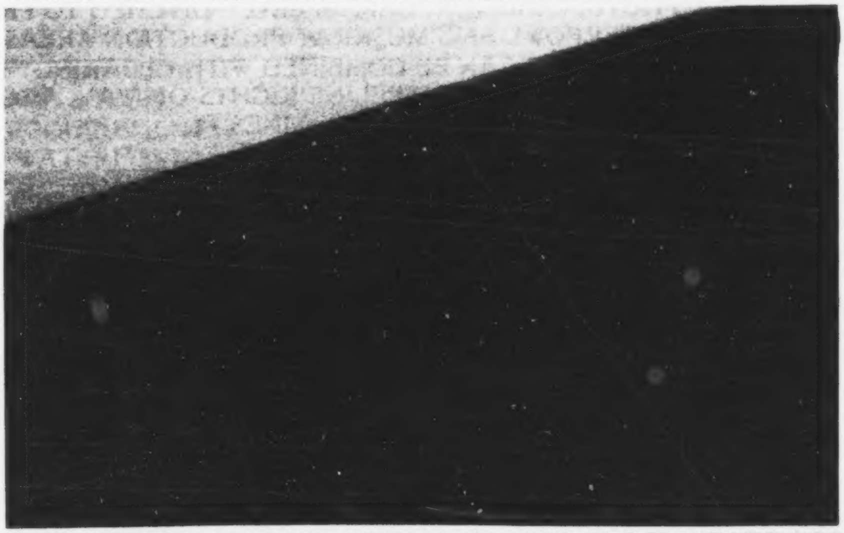


PLATE 2 THIS FARMSTEAD WAS ABANDONED OVER FORTY YEARS AGO IN THE AREA NOW KNOWN AS CANADIAN FORCES BASE SUFFIELD. THE SHELTERBELTS SURVIVED AND PRODUCE NOT ONLY THE BEST, BUT THE ONLY REAL SHELTER AND COVER FOR AS FAR AS THE EYE CAN SEE. THESE SHELTERBELTS PROVIDE SHELTER AND NESTING SITES FOR A LARGE NUMBER OF SPECIES OF MAMMALS AND BIRDS.

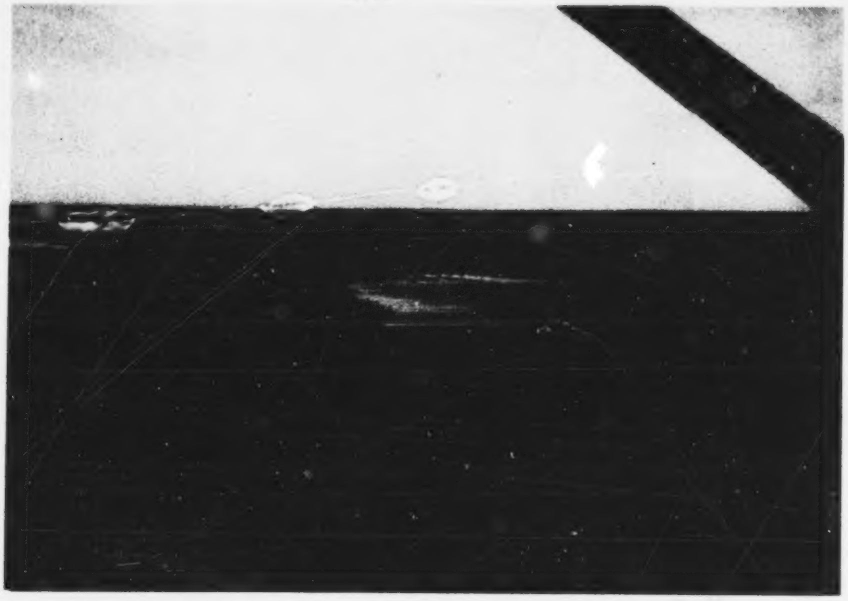
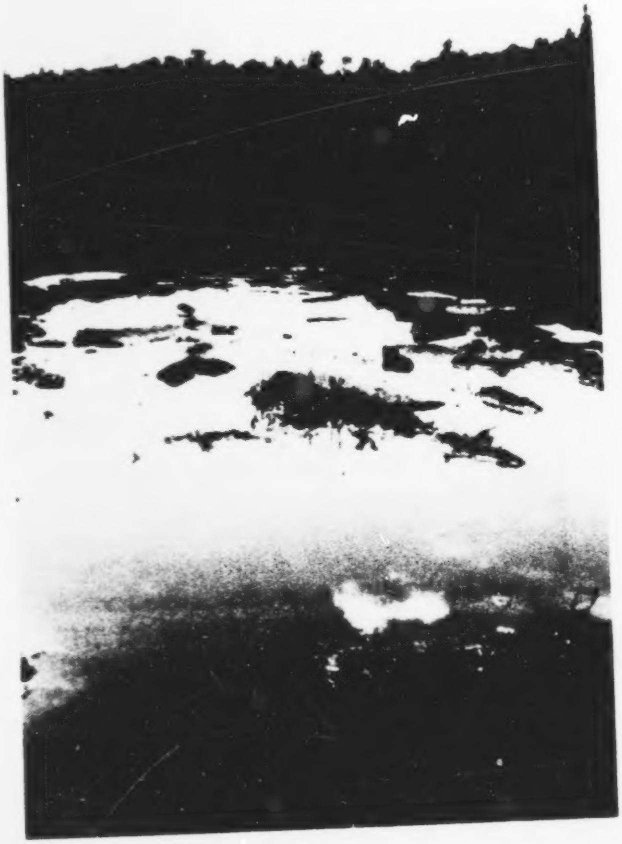


PLATE 3 IN THE COLD LAKE AREA OF ALBERTA, LAKES SUCH AS THE ONE IN THE PHOTO ARE NUMEROUS BUT NOT VERY PRODUCTIVE FROM THE WATERFOWL POINT OF VIEW. THE FEN IN THE LEFT OF THE PHOTO, HOWEVER, CAN BE LEVEL DITCHED TO PRODUCE GOOD WATERFOWL AND MUSKRAT PRODUCTION AREAS. SUCH PRACTICES CAN BE COMBINED WITH CLEARING AND PREPARATION OF PIPELINE RIGHTS-OF-WAY, ACCESS ROADS, DRILLING PADS OR POWER LINES.

PLATE 4
POTHOLE BLASTING
IN THE COLD LAKE
AREA USING VELOGEL.

PLATE 5 THE POTHOLE IMMEDIATELY AFTER THE BLAST.

PLATE 6
THE END RESULT - SHALLOW PRODUCTIVE POND WHICH PROVIDES THE REQUIREMENTS FOR BREEDING WATERFOWL, SHOREBIRDS AND AQUATIC FURBEARERS. CANADIAN WILDLIFE SERVICE SURVEYS THE FOLLOWING SUMMER (L. SHANDRUK, PERS. COMM.) INDICATED HEAVY USE BY SHOREBIRDS, WATERFOWL AND MUSKRATS.



This slide (Plate 7) shows a pumping station near Fort Simpson. The cutlines which you see in the photograph produce a lot of good browse for big game animals including moose. They probably also provide good runways for other animals and are utilized by smaller predators as well. These kinds of habitat manipulation which are done by "accident" can be capitalized on.

This slide shows a borrow pit (Plate 8) from which material was taken to build a road along the Dempster Highway. It doesn't take much imagination to see that the pond, with a small amount of manipulation could be utilized to produce fish, provide nesting sites and breeding sites for waterfowl, muskrats and beavers. These kinds of things are done by accident rather than design and I believe we are missing the boat by not taking advantage of such situations for game management. Even on a small scale the cumulative effect from a lot of such initiatives would be substantial.

This slide (Plate 9) shows permafrost subsidence along the pipeline right of way and has produced a nice wetland which is highly productive from the standpoint of waterfowl, muskrats and moose pasture etc.

This slide shows a powerline right-of-way in the Yukon (Plate 10) where there was a lot of use by ungulates.

Now we'll look at some habitat manipulation. We set up a project in the Cold Lake Oil Sands where we manipulated habitat to see what we could get in response. We went into a large decadent willow area in the muskeg and utilized a hydro-ax (Plates 11-12). It's like an enormous lawn mower (Plates 13-14). Even in the wet spring we didn't disturb the surface to any degree. We pattern cut the area in small 2-3 acre patches. This slide shows what the area looked like after one of these machines went through (Plate 15). The next spring this is what it looked like. We had an excellent response to the treatment. Very high quality browse with a lot of good cover right around it was produced. Approximately 40% of the new vegetation was browsed (Plate 16).

PLATE 7 CUTLINES AROUND THIS PUMPING STATION NEAR FORT SIMPSON PROVIDE BOTH EASIER ACCESS AND A NEW SOURCE OF BROWSE SPECIES FOR UNGULATES AND SMALL MAMMALS AND BIRDS IN THE AREA BY SETTING BACK PLANT SUCCESSION AND CREATING "EDGE".

PLATE 8 A BORROW PIT ALONG THE DEMPSTER HIGHWAY WHICH, WITH SOME FORETHOUGHT, COULD HAVE BEEN (AND MIGHT STILL BE) USEFUL FOR PRODUCTION OF BOTH FISH AND WATERFOWL.

PLATE 9 SUBSIDENCE OF PERMAFROST ALONG AN OLD PIPELINE RIGHT-OF-WAY IN THE YUKON HAS PRODUCED A WETLAND WHICH PROVIDES HABITAT FOR USE BY WATERFOWL AND PROBABLY MUSKRATS AND MOOSE AS WELL.

PLATE 10 THIS POWERLINE RIGHT-OF-WAY IS NOT AESTHETICALLY PLEASING, BUT IT PASSES THROUGH A CLIMAX SPRUCE FOREST. IN DOING SO IT CREATES A CERTAIN AMOUNT OF "EDGE", SOME NEW FORAGE AND AN EASY ACCESS ROUTE FOR MAMMALS IN THE AREA.

PLATE 11 THIS AREA OF DECADENT WILLOW IN A CREEK BOTTOM WAS USED TO TEST OUT A PATTERN CUTTING OPERATION TO TRY TO CREATE NEW FORAGE FOR MOOSE AND DEER.

PLATE 12 THE NO. 720 HYDROAX WAS USED TO CLEAR THE AREAS. THE ENORMOUS ROTARY BLADES ARE DRIVEN BY A 250 B.H.P. ENGINE ALLOWING THE MACHINE TO REDUCE TREES UP TO 20 CM IN DIAMETER INTO WOOD CHIPS. SURFICIAL DISTURBANCE IS ALMOST NEGLIGIBLE.

PLATE 13 THE HYDROAX IN ACTION

PLATE 14 THE SAME AREA AFTER THE HYDROAX HAS COMPLETED ITS WORK. SURFICIAL DISTURBANCE IS NEGLIGIBLE.

PLATE 15 SUMMER FOLLOWING THE USE OF THE HYDROAX (3 MONTHS LATER) SHOWS A REMARKABLY HEALTHY STAND OF NEW WILLOW SHOOTS SURROUNDED BY HEAVY COVER AREAS. THUS, COVER AND FOOD SOURCE ARE IN CLOSE PROXIMITY TO EACH OTHER.

PLATE 16 SOME FORTY PERCENT OF NEW WILLOW IN THE PATTERN CUT AREAS EXHIBITED BROWSE BY UNGULATES.

Discussion

RR Was that a mulcher that you used?

CS It's called a hydro-ax. It's a back hoe with a blade on the front about 7 feet in diameter with 2 blades on the end. It can take a tree some 8 inches in diameter and turn it into wood scraps. It has a 250 horse power engine turning the cutting blades.

The kinds of areas I'm interested in are not large e.g. 2 or 3 acres. I certainly don't think in terms of the wholesale elimination of a climax forest. By cutting back 2 or 3 acres here, 5 acres there, the amount of climax habitat that you're eliminating for caribou is miniscule. You may increase moose browse sufficiently to raise 3 or 4 more animals in a specified area. I believe that in areas were there is high productivity, protection is the answer. If you have areas where caribou or waterfowl etc. are abundant then they should be protected. But there are a lot of areas where there is low production of those species and with a small amount of habitat manipulation you can achieve a lot. There are inexpensive things that might accompany construction so that you can maximize the benefits to wildlife. I've seen many examples of accidentally created habitat and feel wildlife biologists should be able to create that habitat on purpose.

RB They have wildlife extension for land owners. These people have the technology "down pat" to improve habitat for wildlife on private land. They show slides etc. to get their message across. I'm wondering if you could have an extension group (wildlife and fisheries) who's clients are the oil and gas industry, not the private land owner. Maybe they already do this type of extension in the U.S.

CS I like the idea of going to the mining industry and the oil industry because they have land tenure in large amounts. Also, when the natives finally get their land claim settled they're going to be land owners and they will be interested in these kinds of things. They'll make money because of it eg. because of improved trapping etc. They're going to come to us and say, listen, we want to raise these species, can you help?

At that point, you have not only established a viable activity, you have created a justification for your existence. The research questions that come in will be very practical at that point and it'll be a lot easier to justify the need for more wildlife biologists. It's easy for agricultural specialists to justify their existence because they've always got farmers asking them very pointed questions about very practical problems. We don't have that in wildlife. We ask ourselves the questions.

LH Do you see any opportunities for enhancement of wildlife values by bringing water into grazing areas by ditching projects on roads?

CS Yes. We are talking here about terrestrial and aquatic habitat manipulation eg. to create waterfowl habitat.

CK The conversation has been centering around wildlife but it seems to me that a lot of the comments could also be applied to fisheries. The highway could provide an opportunity for an enhancement of a fisheries resource as well as wildlife.

CS You are right. Some fisheries habitat enhancement techniques could be very inexpensive.

DW With regard to the borrow pits, quite a few in the south are being used for aquaculture ponds. After a year, they're used for trout raising. The work is generally done on a private basis, but the techniques could be used in the north if the ponds are deep enough and have enough oxygen for overwintering.

CS There's about 100 odd borrow pits in a particular stretch of road which I'm familiar with. Each one has water and they've all got 2, 3, 4, or 5 pairs of waterfowl.

CK The borrow pits are one area we can look at, but what about stream crossings? People are going in there and altering the area for a few hundred yards. What is the potential there for improving the aquatic environment?

CS Stu Smith, a collegue of mine in Edmonton, has got some ideas on habitat enhancement. One trick he suggested, and he says it's been tried elsewhere, is to take sacks of wheat and put them upstream in a pool and leave them there for the summer. This creates a food source for various kinds of invertebrates which in turn provide food for the fish in the area. There are other techniques that are probably more expensive and some that are less so.

RB Just providing simple access for fishermen to the streams doesn't qualify as habitat enhancement but if it is done properly it can be very effective. If access is not controlled 4 wheel drive vehicles etc. destroy shoreline vegetation, cause sedimentation and generally degrade the aquatic habitat for fish.

DW We can create habitat, but because we are creating artificial situations we may be putting these animals in jeopardy. For example, if we create a lot of duck ponds along the road, how much mortality do we create if it's a heavy traffic area? How much more does it cost us as managers because we have to manage these artificial situations. If we attract moose to the sides of roads are we benefiting the moose? Are we doing ourselves a favour? What are we trying to do as managers? I think we have to look at that very carefully. We have to decide what our objectives are first.

CS I'd rather try a few things and see if we can't create something, if we make mistakes we can learn from them. If more roads are built then we should use the opportunity to produce wildlife, not just sit back and prepare plans.

BG If any of you have driven the Mackenzie Highway, it's nice to see an opening along the side of the road. All you see is trees, and then you come across one of these borrow pits adjacent to the road; a nice little pond with vegetation along the edge. There are opportunities here for both wildlife hunting and viewing.

RR I think the thing that should be remembered is that it is a guideline (to screen borrow pits from the road), and not a positive rule.

BG I agree with you and I'm not saying that the guidelines are wrong.

RR Most people feel that the idea of dog-legging these pits and keeping them away from the road pleases them. I think the general public prefers that.

DISCUSSION OF ENVIRONMENTAL PROTECTION RECOMMENDATIONS FOR RESOURCE ROADS

by

Robert Baker

RB I recommend that maintenance staff should not use road graders; my concern here is that if you're going to have erosion control at stream and river crossings during construction, it doesn't make sense to have maintenance staff come in later and negate those efforts. I'm suggesting that road maintenance staff should not use road graders to clear vegetation within 30 metres of major streams, rivers or wetlands and within 8 metres of minor streams. These areas should be clearly marked to assist the equipment operator. When maintenance clearing is required in these areas it should be done by hand or by mower. Such operations should be restricted to a strip of land 4 metres wide on either side of the highway, wider areas should be cleared (up to 9 metres) in areas prone to icing and on curves.

RR That's a good point. I think they've pretty well stopped this practice in the NWT haven't they?

BG No, and they're going to continue.

RR They should phase out the graders and use vegetation cutters for roadside maintenance. The best way to do it is to grade the backslopes and so forth so you can operate this kind of machinery.

RB In Alaska and in the Yukon they've got vegetation mowers.

RR Whether or not we have mowers in the NWT is a question of money. In Alaska they found that the surface has to be prepared to minimize mower down time due to rocks etc.

RB They have well landscaped roadsides in Alaska and here one mower can clear approximately 650 km of roadside/year.

RR I've been trying to encourage the Territorial Government to do this for years. Money is the problem, I'm sure.

RB Well, the situation is certainly different in the Yukon. They are moving now to eliminate the existing "scorched earth" policy and substitute more reasonable roadside maintenance practices. I'm suggesting that road graders not be used for roadside maintenance at stream and river crossings. I'm not suggesting that they give up this activity all together. Perhaps the activity could be phased out over a number of years.

BG I agree that there should be a limit for maintenance clearing near stream crossings, but I don't think you'd want to specify 4 metres and 9 metres. I like the idea of using 100 metres for all creeks, period. Then you don't leave any interpretation up to the individual operators.

DW I can give you an idea of how they have classed streams in Saskatchewan. A Class one water course requires a reservation of 15 metres or 50 feet. Water bodies in Class Two water courses require 30 metres or 100 feet. Water bodies in Classes Three and Two, which contain populations suitable for angling or commercial exploitation or which are capable of containing such fish populations through stocking require a reservation of 90 metres or 300 feet. Where the width of a flood plain exceeds these specific reservation widths the approving agency may designate the entire width of the active flood plain as a reservation. In such instances, the floodplain should be avoided by all construction activity except those required at water course crossings. Within these guidelines they have definitions for each class of stream. A Class 1 stream would be a small stream which has a gross drainage of 50 square kilometres or 20 square miles etc. If a road is going thru an area they will establish classes for each stream and implement these reservations. Reservation sizes are flexible and can be modified on a site specific basis.

RR So after the construction contouring, backsloping, and ditches have been completed the graders should not operate in the vicinity of streams. You should only put mowers and mulchers in after that.

RB Or hand clear.

RR Well nobody could argue against that.

RB The next recommendation is that shoreline vegetation removal should not take place at river and stream crossings prior to culvert installation. I also suggest having narrow rights-of-way in the approaches to river and stream crossings and the clearing of vegetation during the winter prior to the installation of the crossing structures.

DW In every situation you may not be able to do that, but whenever possible it is desirable.

RB The next recommendation is from the Liard Highway but is intended to apply generally. Specific sites should be designated for waste fill and should be well removed from rivers and streams.

BG That I think we could live with.

RB The next recommendation is that all culverts should be installed on the stream gradient.

RR That's the first thing anybody learns about culverts.

AD Why don't engineers do it then?

MC The involvement of some biologists with the engineers should be taking place in the actual construction of the culvert. In some cases the culvert is installed way above the original stream bed, sometimes by 2 or 3 feet.

RB What about this next recommendation: culvert inverts should be installed below the natural stream bottom. More sophisticated criteria are needed which relate culvert diameter to optimum depth for installation of the inverts.

RB The next recommendation suggests that heavy equipment should be kept clear of shoreline areas on either side of crossing structures except when and where they are absolutely required. Sections of shoreline which are not to be disturbed should be clearly marked to assist heavy equipment operators since a bulldozer can completely destroy such areas within minutes. It is also recommended that an environmental briefing program be developed for equipment operators.

BG I like that one. In the normal course of maintenance of highways, they always seem to have heavy equipment wandering up and down the shoulder of the road and through creeks. We have severe erosion caused by these operators.

RR A big reason for this workshop is that most construction operations are not carried out the way they are supposed to be. It's not really a question of developing more guidelines.

CS What about this: "we recommend that more enforcement or stricter enforcement be placed on the existing rules and regulations."

RR That really sounds right to me.

BG Yes, that I think that would be better.

RB The last recommendation suggests that care be taken to make sure that highway maintenance practices at stream and river crossings compliment any environmental protection efforts made during construction operations. A road maintenance manual should be prepared to ensure that this happens. I don't know that a complete manual is required everytime a road is built but I am suggesting that there be some guidance or follow-through between construction at stream crossings and the maintenance initiatives that follow after.

RR There's a real need for that. Some years ago I tried to change the policy on this subject. What I tried to get was a formal transfer from the construction to the maintenance organization. The main idea was that all environmental reports, stipulations and procedures which were used during highway construction would be passed on to the maintenance people who would have the responsibility for ensuring that they were followed. The way to do that is to adjust the transfer procedure between the construction and maintenance establishments.

DISCUSSION OF WORKSHOP RECOMMENDATIONS

by

C. Surrendi

CS I've put together some recommendations which we can discuss now. First, after considering alternatives, and where a road is perceived to be required, the planning for initial access to an area should include the needs of other renewable and non-renewable resources and resource users. Road planning must be considered in the context of regional transportation and land use planning and resource management plans and programs.

RR The recommendation I'd like to see is as follows: land use planning should be expanded as quickly as possible; of course the planning of transportation corridors is part of land use planning. One of the areas I'm alluding to is the southwest corner of the NWT and the Yukon.

RB The main concern in the Yukon is that other resource users should be considered when a road is located. There are people around the Cadillac Mine area that do things other than extract minerals and their requirements and needs should be considered in the location of the road.

WB For a road, one of the most important things to consider is public utilization. The problem with some of these exploratory development roads is that they satisfy the needs of a single user. But when the road is there, people want to use it to go hunting or look at the wilderness. That has to be considered in any kind of planning but its not being done.

RR The first thing we do is look at all the other roads around for possible connections and alterations. But in the case of Cadillac you could not connect it to another road. So there's only one thing to do and that is to let them put the road in there that serves the mine in the best possible way with the least possible environmental damage.

LH In the case of that particular mine was there not a possibility of a road coming from the north?

RR Yes there was to be a road from the north, but it was a great deal longer.

LH Were they able to consult with the people in Fort Simpson to see if they would prefer that road or if the new road had to be built?

RR I think the people of Fort Simpson have had their say about these things.

LH In September of 1979 the Territorial Council met with people from Parks Canada and one of the things that some of the counsellors said was that they should build a road up the Nahanni River. Was council ever approached with the idea that there might be a road that would combine access to Nahanni National Park with access to Prairie Creek?

BG Parks did not want an access road into Nahanni National Park. They were quite disturbed that there was one going into Cadillac.

LH Personally, I agree with Parks in that area. But there are people who have an interest in the situation and I just want to know whether they were considered.

BG There were a number of public meetings held throughout the district, not just in Fort Simpson but Nahanni, Butte, Wrigley and Fort Liard. I think everybody got a "kick at the cat".

WB I don't know about that. Nahanni National Park is supposed to be for all Canadians. Right now it's not available to the average Canadian because of lack of access. A road would have made a difference and I question whether sufficient people were consulted on this matter.

SD The only thing about the Cadillac road that the Department of Environment was upset about was the fact that one section was permanently built prior to the issuance of final approval for the mine.

CS The construction of a road into a new area has a tremendous influence on land use planning because nothing was there before. The plan has a tendency to evolve around the road. Ideally the land use plan should determine where the road should go.

SD I don't believe that the Department of Indian Affairs and Northern Development has a land use plan(s), for the Northwest Territories. They're waiting for land claims to be settled, so you have to deal with that reality up here.

RR There's an enormous amount of work being done by the Lands Directorate and eventually they will be putting together this work; then we'll have a land use plan(s). But it won't be put together until a little more of this land claims business is settled.

CS We're talking about land use planning rather than a land use plan. The idea that there may be other resources in the area, and that roads should be built so that they are influenced by these other resources and resource users should be kept in mind when doing land use planning.

SD That situation already exists if you're talking about land use planning on a small scale. The Department of Indian Affairs and Northern Development does consider other resource users.

RB Should this workshop develop guidelines? Is there a need for such guidelines?

BG If we start drawing up guidelines/recommendations we'll find they've already been written. The wording may be different but they're in existence. Maybe what we should be doing is locating them, putting them together and getting them to the appropriate people. I'm sure that most of them exist within the land use regulations.

DW I tend to agree with Bernie. We do have guidelines and it's a matter of getting them together and selecting those that are appropriate for individual jurisdictions. But no matter what technical aspects you have it's the mechanism, the administrative capability of getting them into effect, that's the problem.

WB I agree. There is excessive duplication and fragmentation in government decision-making in the north. The permitting process needs to be streamlined and government has to stop reacting to projects in a piece meal, incremental fashion. Does it make sense, for example, to deal with the road to the Cadillac project without reference to the mine or the air strip. Such projects have to be dealt with in an integrated fashion and well in advance of receipt of the first permit application.

SD The short time frame allowed for review of permit applications is one problem that has to be dealt with.

JD The problem is defining what exploration is and what development is. The difficulty that we're having most recently is with Cadillac. The argument they made was that they needed the road to enable them to explore or to continue their exploration program into detailed phases. But Cadillac used the road to move a mill onto the site. Now if that's exploration, I'm really surprised at the latitude of the definition. In fact, the land use permit was granted when it was for one reason, it would put their development schedule back a year if they didn't get it.

DW I can give an example. We had a situation with the Key Lake Mine where they had to drain the lakes in order to get a better estimate of the ore body. At what point does that become exploration? At the exploration phase there's a lot of environmental damage being done and we don't have any control over it. That's something that really has to be looked into. Should there be terms of reference for exploration and terms of reference for development?

LH There's a basic principle which is that unless there are extraordinary circumstances, whoever has a mining property or an oil well etc. will be allowed to build a road there. There are certain constraints, obviously, because of particular sensitive areas. Approval in principle for roads should be automatic with emphasis placed on proper environmental design.

AD So you're saying that the option for a no-go doesn't really exist except in extreme circumstances.

LH Our efforts should be towards preventing impact and enhancing natural values by whatever methods we have at our disposal. I think we have the methods at our disposal. I also believe we should identify those areas of particular importance and avoid building roads in those areas. These areas should be identified right now.

AD Therefore no exploration should be permitted if they are identified in advance in those areas.

LH That is obviously impractical but we should urge the agencies responsible to proceed with utmost haste to identify these areas.

There hasn't been comprehensive land use planning in a regional context, and there should be. And to do that you have to first identify those areas that should not be developed and then assume that other areas can be developed with appropriate regulations.

RB Are you proposing an extensive sensitive area mapping scheme.

LH No, I'm not recommending detailed areas because the environmental design of any project can address this. I'm talking about areas of regional or national importance; really major areas. If it's decided that we should protect the worlds largest caribou herds then we should find out where they live and not threaten them. If it's an area of national importance e.g. the northern Yukon, then roads should not be built there. But for the other areas, lets assume that we can build roads there. Lets also assume that, if a gyrefalcon nest is in the area, the road can be designed to go around it. Measures can also be taken to protect sheep habitat etc.

Wayne has said that decision-making is fragmented. I think it should be put in one place. I have my own opinions of where that should be, but for now it's with Indian and Northern Affairs. They should have the jurisdiction, should centralize and get organized.

I do not think that environmental management and protection agencies should have to spend their time telling the Department of Public Works how to build a culvert. They should be playing an advocacy and avisory role to agencies having authority for permitting land and water uses.

CS I heard yesterday from people in this room that a lot of the locations of fairly large mineral deposits in the Yukon and the NWT are already well known.

LH Anybody in this room could draw a circle around all the geological explorations already known.

CS We probably have a good handle on the location of a number of areas of national environmental importance eg. parks. Why doesn't DIAND or the territorial government put the mineral locations and regionally significant environmental areas together on a map and lay out a very preliminary plan for roads in the NWT?

RR They're trying to do that in Ottawa now.

LH The principle has a good precedent in the Viscount Melville area. EMR wanted to issue some leases and they gave us a list of prospective drilling areas and asked us to tell them which ones are, or might be, environmentally sensitive and they said they would not issue leases for those areas.

RR The North-East Mackenzie District transportation study is another useful precedent, although it is is strictly economic. Nevertheless, I think it makes sense to do economic studies first to see which types of transportation, if any, are economically feasible for a region. That will be followed by the land use and ecological work.

RB This kind of regional planning is being done in the state of Maryland. For refineries, steel mills and so on they indicate general areas where applications for permits to build a refinery or a steel mill or other types of installations will be favourably received. They identified areas that were feasible from a technical economic and environmental standpoint. They did not say specifically where these installations should go but merely indicated, in a general context, where applications would be favourably received.

LH After all these years the job of putting in roads should be done properly. I think we have the knowledge. Let Indian Affairs go and do it.

RB But what if they don't put the roads in properly? Some pretty serious concerns have been voiced at this workshop over the past two days.

LH Then we should play an advocacy role as long as its not being done properly. But we must bear in mind we're biologists, not road designers. The recommendation by this workshop should be that resource management agencies should start thinking long term. Once we've got regional land use plans indicating where roads are going to be in the future, we should start collecting environmental baseline data.

RB I agree, but are you aware that the DOE baseline studies budget for the whole of Canada is only $250,000.

LH There should be operational funds identified on a year-to-year basis for agencies to undertake the studies that are required.

CS It is clear that information on fisheries, wildlife, parks, areas of interest in regard to mineral bodies, forest areas etc. is already available. It is therefore recommended, that a draft plan of possible road sites be drafted by NWT, DINA and DOE based on the locations of the above general areas. This plan can be updated as the information is refined.

LH Great. That will serve as a guide for the studies I was just talking about.

RR The Roads and Airstrips division in Ottawa is supposed to do exactly that. They're working on it constantly.

CS Another recommendation is to complete the linear facilities study that was started a couple of years back. I've heard that we lack documentation on the monitoring of existing facilities and that could be a valuable tool when used for planning.

LH I couldn't agree more.

BG If you haven't done the monitoring you haven't done the whole job.

CS What we will get, if the monitoring study is completed, is a sound base which will eliminate a lot of work from the EIS. We won't have to do extensive environmental assessments to find out what the impacts are going to be. We will have most of the answers from the monitoring of existing facilities.

I find it repetitive and expensive to continue doing the same kinds of crash environmental impact studies on the same kinds of projects time and time again. I would like to go back, after the fact, and find out what really happened. What really was the influence on the environment from a pipeline or road that was built 40 years ago?

I sat in on the Foothills Hearings and there were people running all over the place, flying in helicopters looking down at bushes trying to determine what the effect of that pipeline was going to be. Nobody went out and looked at the old one that was lying on the other side of the road. Lee and I got together and decided it would be reasonable to check a pipeline that was there for a long period of time. We found it was actually productive from the standpoint of game species and it did have benefits that were never documented.

RR Just vigorously promoting that idea alone might make this workshop worth while.

CS Nobody's standing there watching to see if our environmental impact predictions are coming true and I guess I'm getting tired of that kind of thing.

RR I have a final recommendation. Somebody should list all the Boards, Committees, and other Government decision-making entities in the north (that are relevant to northern roads) and note how they interact, then get rid of the duplication and ensure there is good communication etc.

RB I think you've got something Rolley. Various people at this workshop have indicated that part of the problem is not so much the fact that we lack in recommendations and good environmental design practices but that the implementation mechanism leaves a lot to be desired. That being the case, your suggestion would go a long way torwards resolving this problem.

RR I agree.